NPOESS

TECHNICAL REQUIREMENTS DOCUMENT
Version 7
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NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

Version 7

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TECHNICAL REQUIREMENTS DOCUMENT
FOR THE
NATIONAL POLAR-ORBITING OPERATIONAL
ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

CONTRACT NO.

PREPARED FOR:
NPOESS - INTEGRATED PROGRAM OFFICE
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Date_____ Date_____

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1. SCOPE

1.1 IDENTIFICATION

This Technical Requirements Document (TRD) sets forth the requirements of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) which is hereinafter referred to as “the System”. As the Command, Control, and Communications (C3) and Interface Data Processor (IDP) segments of “the System” also support the NPOESS Preparatory Project (NPP) as part of the NPOESS risk reduction program, additional requirements have been included that relate to NPP. Therefore, all the requirements of this TRD apply to both NPOESS and NPP unless a requirement specifically states “Not Applicable to NPP” or “NPP ONLY”.

1.2 SYSTEM OVERVIEW

The purpose of the System is to collect global multispectral radiometry and other specialized meteorological, oceanographic, and solar-geophysical data and to disseminate these data to the system's central users and field users deployed worldwide. These data are processed and delivered to the users in the form of Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), and Environmental Data Records (EDRs).

1.3 DOCUMENT OVERVIEW

This document contains all performance and support requirements for the System. In addition, all inter-segment and external interfaces are defined for the System. To avoid duplication, requirements that normally would appear in both 3.2 System Characteristics and 3.7 Segment Characteristics are only stated in section 3.7.

The documentation listed in section 2.0 follows an approach of minimum specs and standards. It is expected to be the basis of a system specification to be proposed by the contractor. The contractor may add to or revise the documents listed in section 2.0 with approval from the government.

The term *"TBD"* applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term *"TBS"* means that the government will clarify or supply the missing information in the course of the contract. The term *"TBR"* means that the requirement may be reviewed for appropriateness by the contractor or the government and may be changed by the government in the course of the contract.

Appendix A contains a definition of the terms used throughout the document. Appendix B contains the NPOESS survivability requirements which are classified and available in the NPOESS contractor libraries. Appendix C is the NPOESS Baseline RF Requirements for C3 Links. Appendix D contains the specific EDR requirements. Appendix E contains the Data Products required for each Central and Field Terminal. Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes additional NPOESS mission needs which have potentially restrictive technical or programmatic uncertainties and which are beyond the current NPOESS baseline requirements.

1.3.1 Precedence

1.3.1.1 Requirement Weighting Factors

The requirements stated in this specification are not of equal importance or weight. The weighting factors that are incorporated in this specification are specified below.

a. ***Shall*** designates the most important weighting level; i.e. mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.

b. **S*hould*** designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the *should* requirements does not require approval of the contracting officer.

c. ***Will*** designates the lowest weighting level. These *will* requirements designate the intent of the government and are often stated as examples of acceptable designs, items and practices. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

1.3.1.2 Conflicts

TRD1.3.1.2-1 DELETED

TRD1.3.1.2-2
In the event of a conflict involving the Sensor Requirements Documents, the General Instrument Interface Document, the sensor System/Subsystem Specification, or the external interface requirements of the System, such as a conflict with equipment external to the System being specified, or in the event of any other unresolved conflict, such as a conflict with government furnished property, the contracting officer shall be notified, and the order of precedence will be as directed by the contracting officer.

1.4 SYSTEM CLASSIFICATIONS

The operational capability of this System is to be implemented incrementally such that the System can transition without major disruption through the following baseline classifications:

a. NPP (Risk Reduction Mission)
b. IOC System (Initial Operational Capability System)
c. FOC System (Full Operational Capability System)

The requirements stated in this document that are not identified as applying to a specific system classification apply to all of the system classifications. Requirements stated as applying to the initial operational capability system also apply to the full operational capability system, unless stated otherwise in the text.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this TRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is permissible subject to government approval.

STANDARDS:

Military

DOD 5200.28-STD Mar 88	Department of Defense Trusted Computer System Evaluation Criteria
MIL-STD-461E Aug 99	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A Dec 87	Electromagnetic Compatibility Requirements for Space Systems
31 March 2000 Version 3.1 (TBR)	Department of Defense (DoD) Joint Technical Architecture (JTA) Joint Interoperability and Warrior Support
Version 3.1, 1 October 1998	Defense Information Infrastructure Common Operating Environment, Integration and Runtime Specification

OTHER PUBLICATIONS:

Regulations

AFM-91-201002 7 Oct 94	Explosives Safety Standards
EWR 127-1 31 Oct 97	Eastern and Western Range Safety Requirements
19 Sep 1996	National Space Policy

Other

GIID, (TBS)	General Instrument Interface Document (GIID)
SRD Common Section Version 2, Rev c, 31 May 00	NPOESS Sensor Requirement Document Common Section (This will eventually be replaced by the GIID)
EELV SIS, Version 6, 5 September 2000	Evolved Expendable Launch Vehicle Standard Interface Specification
NTIA 31817/1 02 March 2001	NPP Stage 2 Certification of Support
NTIA-44 Aug, 1999	NPOESS Stage 2 Certification of Spectrum Support

NAIC-1571-727-95 11 Sep 95	Space Systems Threat Environment Description (TED), S/NF/FRD
NAIC-1574-0110-01 April 2001	Defense Meteorological Satellite Program (DMSP) / National Polar-Orbiting Operational Environmental Satellite System (NPOESS) System Threat Assessment Report (STAR), Secret
NASA/DoD, 1997	US Government Orbital Debris Minimization Standard Practices
NSTISSP No. 12	National Information Assurance (IA) Policy for US Space Systems http://www.nstissc.gov
NAVSTAR GPS JPO SS-GPS-001, 12 March 1998	NAVSTAR Global Positioning System (GPS) Selective Availability Anti-Spoofing Module (SAASM) System Specification [FOUO, Export Restrictions Apply]
NIMA TR-8350.2 3 Jan 00	DoD World Geodetic System 1984 http://164.214.2.59/GandG/tr8350_2.html
FIPS Publication 197 November 26, 2001	Specification for the Advanced Encryption Standard

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specified acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 NONGOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this TRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is permissible subject to government approval.

STANDARDS:

See Web site for current standards http://wwwdev.ccsds.org/blue_books.html	Consultative Committee for Space Data Systems (CCSDS) Blue Books

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because they have been referred to in various parts of the TRD.

SPECIFICATIONS:

Military

STANDARDS:

Military

MIL-STD-961D 22 Aug 95	DoD Standard Practice for Defense Specifications w/Notice 1
MIL-STD-882D 10 Feb 00	Standard Practice for System Safety
MIL-STD-1246C 11 April 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1472F 23 Aug 1999	Human Engineering Design Criteria
MIL-STD-1522A May 84 Notice 2: 20 Nov 86; Notice 3: 4 Sep 92	Safe Design and Operation of Pressurized Vessels, Missiles, and Space Systems
MIL-STD-1542B Nov 91	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
Mil-A-83577B Feb 1988	Assemblies, Moving Mechanical, For Space And Launch Vehicles, General Specification For

Department of Commerce

September 1995 Edition	National Telecommunications and Information Administration "Manual of Regulations and Procedures for Federal Radio Frequency Management"

NOAA

S24.801 Nov 72	Preparation of Operations and Maintenance Manuals, Revised Apr 97
S24.804 22 Jan 73	General Requirements for Training on Electronic Equipment, Revision One 08/04/87
S24.806 Jan 86	Software Development, Maintenance, and User Documentation, Revised Apr 94
S24.809 1 Dec 89	Grounding Standards
19 Nov 98	Agreement between NOAA and the European Organisation for the Exploitation of European Meteorological Satellites (EUMETSAT) on an Initial Joint Polar-orbiting Operational Satellite System
8 Jul 99	Program Implementation Plan (PIP) for the Cooperation Between NOAA & EUMETSAT on an Initial Joint Polar-orbiting Operational Satellite System

NASA

SP-R-0 022A (JSC) 9 Sept 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application
PPL-21 March 1995 Updated May 1996	Preferred Parts List PPL-21, Goddard Space Flight Center

Other

EIA/IEEE J-STD-016 30 Sep 95	Standard for Information Technology, Software Life Cycle Processes, Software Development, Acquirer-Supplier Agreement
CJCSI 6130.01B 15 June 2000	2000 CJCS Master Positioning, Navigation, and Timing Plan
CGMS 04 Issue 1 5 October 1998	Coordination Group for Meteorological Satellites – Direct Broadcast Services, LRPT/AHRPT Global Specification

OTHER PUBLICATIONS:

Handbooks

MIL-HDBK-263B 31 July 94	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts. Assemblies and Equipment (Excluding Electrically initiated Explosive Devices) (Metric)
AFM 15-111 1 Sep 96	Surface Weather Observations
FMH 1B	Federal Meteorological Handbook 1B (Note that AFM 15-111 implements FMH-1 and supercedes FMH-1B and AFM 15-111 Volumes 1&2, which were AF extensions FMH-1.)
MIL-HDBK-340 1 July 1985	Application Guidelines for MIL-STD-1540B: Test Requirements for Space Vehicles
MIL-HDBK-1547A 6 July 1998	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-HDBK-83578 1 Jan 1999	Criteria For Explosive Systems And Devices Used On Space Vehicles
MIL-I-46058	Insulating Compound. Electrical (for Coating Printed Circuit Assemblies)
AFM 63-119	Certification of System Readiness for Dedicated Operational Test and Evaluation
ESC-SRD-003 July 1999	System Requirements Document for the Reengineered Air Force Weather Weapon System (AFWWS), Release 2.2

Other

NACSEM 5112(S) Apr 75	Non Stop Evaluation Techniques (U)
NSTISSI 7000(S/NF) 17 Oct 88	TEMPEST Countermeasures for U.S. Facilities (U)
1 Jul 1988	SARSAT agreement, for search and rescue (i.e., emergency transmitter locations).
ITT # 8179801 4 May 00	Cross Track Infrared Sounder (CrIS) System Specification
ITT #8179802 4 May 2000	CrIS Sensor Specification

CMIS SRD Version 2, 30 Aug 2000	NPOESS Conical Microwave Imager Sounder Sensor Requirement Document (CMIS SRD)
PRF SS154640-001, 22 Aug 2000	System Specification For The Visible/Infrared Imager Radiometer Suite (VIIRS)
PRF PS154640-101, 22 Aug 2000	Sensor Specification For The Visible/infrared Imager Radiometer Suite (VIIRS)
GPSOS SRD Version 2, Rev b, 30 May 00	NPOESS GPS Occultation Suite Sensor Requirements Document (GPSOS SRD)
Ball # 54279816 Jan 01	Ozone Mapping & Profiler Suite (OMPS) System Specification
OMPS	[need to add OMPS sensor spec]
SESS SRD Version 1 Revised 10 Jun 99	NPOESS Space Environmental Sensor Suite Requirements Document (SESS SRD) *(TBS)*
AS3-ST-0S1-048 CNES 23 Jan 1998	ARGOS-3 System Technical Specification (Being updated)
(TBS)	Unique Instrument Interface Specification for the Advanced Data Collection and Location System (ADCS) (DRAFT)
(TBS)	Unique Interface Specification for the Search And Rescue Processor (SARP-3) (DRAFT)
IS-23033278	ATN Unique Interface Specification for the Search and Rescue Repeater (SARR) for NOAAs -K, -L, and -M
GSFC 429-00-06-03, Att. B 23 Jun 00	Advanced Technology Microwave Sounder (ATMS) Performance and Operations Specification (POS)
TEMP Version IIC, 23 Feb 01	Test and Evaluation Master Plan (DRAFT)
2 Aug 1995	Training System Requirements Analysis Book
AIAA R-023A-1995	Recommended Practice -- Human Computer Interface for Space System Operations
GSFC 429-99-02-03 12 JUN 2000	National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) Mission Requirements Specification (Volume 1 and 2)
US Naval Observatory http://tycho.usno.navy.mil/	Definitions of Systems of Time at USNO
31 March 2000 Version 3.1	Department of Defense (DoD) Joint Technical Architecture (JTA) Joint Interoperability and Warrior Support
IPO/NASA TDRSS MOA, Dated (TBS)	(TBS)
GSFC 429-01-02-20 (draft 12 Oct 01)	NPP Space Network (SN) Project Service Level Agreement (PSLA)
GSFC 429-01-02-19 (B/L date 3 Dec 01)	IRD for NPP Mission System to Direct Broadcast Users Interface

GSFC 429-01-02-11 (draft 31 Oct 01)	IRD for NPP SS and LSS Interface
GSFC 429-00-02-16 (B/L date 6 Jun 01)	IRD for NPP SDS and C3S Interface
GSFC 429-01-02-10 (B/L date 6 Dec 01)	IRD for NPP C3S and SS Interface
GSFC 429-00-02-13 (B/L date 23 Jul 01)	IRD for NPP SDS and IDPS Interface
GSFC 429-01-02-21 (B/L date 6 Dec 01)	IRD for NPP Spacecraft Simulator and the C3S Interface
GSFC 429-99-04-01 (B/L date 28 Feb 01)	NPP Unique Instrument Interface Document (UIID) for the Visible Infrared Imaging Radiometer Suite (VIIRS) Instrument
GSFC 429-99-05-01 (B/L date 28 Feb 01)	NPP Unique Instrument Interface Document (UIID) for the Cross-Track Infrared Sounder (CrIS) Instrument
GSFC 429-99-06-01 (B/L date 23 Jun 00)	NPP Unique Instrument Interface Document (UIID) for the Advanced Technology Microwave Sounder (ATMS) Instrument

(Technical society and technical association specifications and standards generally are available from reference libraries. They also are distributed among technical groups and using federal agencies. The contracting officer should be contacted regarding the availability of any referenced document not readily available from other sources.)

3. SYSTEM REQUIREMENTS

The following requirements are applicable to both the NPOESS and the NPP. In addition to having performance responsibility for the NPOESS, the NPOESS EMD contractor is also solely responsible for the development and operation of the C3 and IDP segments of the NPOESS Preparatory Project (NPP). The NPOESS EMD contractor is also solely responsible for developing, in conjunction with the NPP spacecraft contractor, all necessary interface requirements between the NPP C3 and IDP segments and other elements of the NPP system. The NPOESS EMD contractor is also responsible for the production, delivery, and support of integration testing of the CrIS and VIIRS instruments on NPP.

Whenever the term "NPOESS" is used in this document, the associated requirement or descriptive material should be interpreted as applying to both NPOESS and NPP, unless a requirement specifically states "Not Applicable to NPP" or "NPP ONLY". In addition, NPP will be operated from a single Mission Management Center (MMC) so references to a backup MMC are not initially applicable to the system. In those cases where the NPP requirement or descriptive material differs from the NPOESS requirement, the difference in the NPP requirement will be clearly stated.

3.1 DEFINITION

3.1.1 System Description

The NPOESS is a System of polar orbiting weather satellites and ground equipment used for the collection, analysis, and dissemination of weather data to government and civilian users. The System shares data with the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Though the role of the EUMETSAT Meteorological Operational Program (METOP) in NPOESS is *(TBS)* pending an international agreement between the United States Government (USG) and EUMETSAT, data from the instruments on METOP satellites may be used in the production of the mid-morning orbit NPOESS xDRs when applicable.

NPP is a risk reduction mission for NPOESS and a continuance of the EOS program for NASA. The NPP mission is considered a bridge between the existing EOS and the NPOESS programs. The mission provides continuity of climate data measurements for NASA and risk reduction for the NPOESS IPO. For NASA, NPP is part of the EOS program, providing extended observations for key sustained measurements identified in the EOS Science Plan. For NPOESS, NPP provides an opportunity to demonstrate and validate new instruments, algorithms, and pre-operational processing capabilities prior to the first NPOESS flight.

3.1.2 System Segments

The System has five major system segments:

a. Space Segment (SS)
b. Command, Control, and Communications Segment (C3S)
c. Interface Data Processor Segment (IDPS)
d. Launch Support Segment (LSS)
e. Field Terminal Segment (FTS)

NPOESS will support additional external interfaces, including:

f. Science Data Segment (SDS) (supplied by NASA, for the duration of NPP only)
g. Long term archives supplied by NOAA (TBS) (including Archive and Distribution Segment (ADS) for NPP only)

As part of NPP, NASA will supply the NPP SS, Advanced Technology Microwave Sounder (ATMS), and LSS.

3.1.2.1 Space Segment (SS) Description

The SS consists of satellites and ground support equipment. The satellites collect global multispectral data on clouds and other meteorological, oceanographic, climatological, terrestrial, and solar-geophysical parameters. The NPOESS satellites also carry the Advanced Data Collection System (ADCS) and search and rescue sensors (e.g. Search and Rescue Satellite Aided Tracking (SARSAT)). The satellites store and transmit all data (except SARSAT) to ground stations, possibly through data relay satellites, and provide a continuous real-time transmission

for receipt of data by field terminals within view of the satellite. [Not all data described above will be collected by the single NPP satellite.]

3.1.2.2 Command, Control and Communications (C3) Segment Description

The NPOESS C^3 Segment consists of shared and dedicated resources: ground stations, Mission Management Centers, communication elements, flight vehicle simulators, and other command and control equipment needed to fulfill the NPOESS mission. The NPOESS C^3 Segment will utilize a cost effective mix of government and/or commercial C^3 assets that are compliant with the International Telecommunications Union (ITU) spectrum regulations. The C^3 functions include Mission Management and Planning, Resource Scheduling, Satellite Operations, Anomaly Resolution, System Security, Relay of Data to the IDPSs, Network Management, and Spacecraft and Sensor Engineering support activities such as launch and early-orbit checkout.

3.1.2.2.1 Ground Station Element

Ground stations provide ground to space connectivity for the C3S. They may be shared facilities with dedicated NPOESS antennas and may include NOAA's Command and Data Acquisition (CDA) ground stations (such as Fairbanks, Alaska), European CDAs (such as Svalbard, Norway), and others including McMurdo Bay, Antarctica and/or commercial command data acquisition stations. C^3 resources/nodes that (1) meet NPOESS operational requirements, (2) are operated in accordance with appropriate international agreements or treaties between the U.S. and the host nation, and (3) have a U.S. government presence or an acceptable commercial contract in place, are considered under U.S. control for the purposes of this program.

3.1.2.2.2 Mission Management Center (MMC)

The primary NPOESS MMC will be located at Suitland, MD and the backup MMC will be at Schriever AFB, CO, unless the use of commercial Mission Management Center(s) is determined to be more cost effective, or government development of Suitland Federal Building 5 does not support NPP/NPOESS requirements and/or timelines. The primary MMC will be responsible for performing the operational functions of satellite command and control, mission management and planning, antenna resource scheduling, launch and early orbit support, ground and space anomaly resolution, telemetry data processing, and the support of data delivery to users. The backup MMC will be capable of performing the same operational functions as the primary MMC, with the exception that launch and early orbit operations will only be done from the primary MMC. The back up MMC at Schriever AFB, CO, will be operated by a cost effective mix of contractor and USAF Reserve personnel.

3.1.2.2.3 Data Routing and Retrieval (DRR)

The DRR will provide all inter-segment communications for the C3S and IDPS. Inter-segment communications include the routing of stored mission data to the IDPS Central element and all telemetry (stored and real-time) data to the MMCs in support of System data availability. The DRR will provide routing for commands, and any other communications among the MMCs, ground stations, Flight Vehicle Simulators (FVS), and IDPS elements.

3.1.2.2.4 Flight Vehicle Simulator (FVS)

The NPOESS and NPP FVS elements will provide high fidelity simulation of the on-orbit spacecraft and sensors. For NPP, the NPP spacecraft contractor will provide the NPP spacecraft simulator and the EMD contractor will integrate it into a full satellite simulator.

3.1.2.3 Interface Data Processor Segment (IDPS) Description

The IDPS consists of ground hardware and software elements which ingest and store (temporarily) the satellite mission data and process them, as necessary, into Raw Data Records (RDRs), Sensor Data Records (SDRs) or Temperature Data Records (TDRs) and Environmental Data Records (EDRs). These xDRs will be received by the four NPOESS Centrals (the Air Force Weather Agency (AFWA), the National Environmental Satellite, Data, and Information Service/National Centers for Environmental Prediction (NESDIS/NCEP), the Fleet Numerical Meteorology and Oceanography Center (FNMOC), and the Naval Oceanographic Office (NAVOCEANO)). NPP IDPS capability will initially be available at NESDIS/NCEP and AFWA, and phased into the remaining DoD Centrals with the installation of the NPOESS IDPS capability prior to the first NPOESS launch. The IDPS element

at NESDIS/NCEP will be the distribution point for data going to the NPP-SDS, NPP-ADS, long-term archives, and the NESDIS/NCEP Central. Only NPP data will be routed to the SDS.

3.1.2.4 Launch Support Segment (LSS) Description

The LSS will provide resources to accomplish launch operations, and to place each satellite into the correct orbit. The LSS includes all launch support equipment including Aerospace Ground Equipment (AGE), Real Property Installed Equipment (RPIE) and launch facilities. AGE consists of test equipment, computer check-out systems, etc. RPIE includes items such as power equipment, air conditioning equipment, and non-flight fuel stores. The launch facilities include payload test facilities and other required equipment/facilities to support ground operations for testing the satellite following integration onto the launch vehicle. [Not applicable to NPP. NASA will provide the NPP launch segment except for any special VIIRS and CrIS test equipment.].

3.1.2.5 Field Terminal Segment (FTS) Description

Field Terminals (NPOESS only) may be land or ship-based, fixed or mobile, and they will receive real-time mission data transmitted from the satellite. The NPOESS Program will supply field terminal software that is capable of processing the NPOESS satellite LRD and HRD data, as appropriate, into the products specified in Appendix E.

3.1.2.6 NPP Science Data Segment (SDS) Description

The Science Data Segment (SDS) ingests the RDRs and telemetry received from the NPOESS system. The SDS validates the format and volume/size of the RDRs, ensuring all data are received. The SDS processes the RDRs, creating a NASA Level 1B product. The Level 1B is comparable to the IDPS SDR product, but is generated using NASA-sponsored, science quality algorithms. The RDRs are stored in the SDS for the life of the mission, permitting reprocessing when improved science algorithms are made available from the science community.

3.1.2.7 Archival Storage

The system will have a single external interface to archival storage. Initially, it will support only the NPP ADS. The interface will evolve to support the full NPOESS data transfer to the NOAA Comprehensive Large-Array data Stewardship System (CLASS) archive.

3.1.2.7.1 NPOESS Long Term Archives Description

A long term archive for NPOESS data will be provided by NOAA, as an element of the CLASS archive, as specified in the appropriate MOU. The archives will receive xDRs (including associated metadata), and configuration-controlled supporting information (e.g., calibrations, algorithms, documentation) from the IDPS. The IDPS will be able to retrieve archived information when needed for internal purposes, such as trend analysis or anomaly resolution.

3.1.2.7.2 NPP Archive and Distribution Segment (ADS) Description

The Archive and Distribution Segment (ADS) element of the NOAA CLASS archive receives the RDRs, SDRs/TDRs, and EDRs from the IDPS and the NASA Level 1B and Climate Data Records (CDRs) from the SDS. The data is archived, as are the calibration files and metadata upon which users may search and order data. Additionally, the ADS will provide xDRs to the SDS when requested.

3.1.3 DELETED

3.1.4 Top-Level System Functions *(TBD)*

3.1.5 System Modes

At the system level, there are three modes of operation: [1] Normal Operations Mode; [2] Selective Data Encryption Mode [Not applicable to NPP]; and [3] System Upgrade Mode. In the Normal Operations Mode, individual segments can be in various segment modes. In the Selective Data Encryption Mode, the System will have the capability to selectively deny all links, except for the SARSAT and ADCS payload downlinks. Mission data access (deniability) is a key performance parameter. Real time and stored telemetry are encrypted in all system modes [Not applicable to NPP]. Mission data are denied when the National Command Authority (NCA) directs NPOESS to go into Selective Data Encryption mode in times of national emergency. In the System Upgrade Mode, the System will support Normal Operations plus all activities involved with a given system upgrade. An example of a system upgrade is the launch and on-orbit check out of a new satellite.

3.1.6 Operational and Organizational Concept

3.1.6.1 Expendable Launch Vehicle Concept

Each satellite will be launched using an expendable launch vehicle with a goal of direct insertion into the operational orbit. The NPOESS budget baseline is a medium class EELV.

3.1.6.2 Launch Operations Concept

3.1.6.2.1 Pre Launch

The satellite will be transported directly to the launch base where final vehicle preparations and checkout will be accomplished. Final inter-segment and launch system verification tests will be accomplished prior to launch.

3.1.6.2.2 Launch and Injection

During launch and injection to the operational orbit, the various satellite subsystems may be powered on or turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. Satellite telemetry to monitor vehicle status will be provided during launch and injection. Transmission of launch vehicle telemetry may satisfy this requirement during the launch phase. Satellite telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. Real-time command and telemetry via the NASA space network will be used during launch, injection, separation, and early-orbit activities of the NPP spacecraft. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments would be initiated by memory command while in view of real time telemetry and command capability. Early orbit check-out will be conducted at the NPOESS primary MMC.

3.1.6.3 On-orbit Operational Concept

3.1.6.3.1 On-orbit Tests

The initial on-orbit period is devoted to a complete satellite checkout and the calibration and performance verifications of the sensor(s). The spacecraft and sensor performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.6.3.2 Initial and Full Operational Capabilities

[Not applicable to NPP.]

The System Initial Operational Capability (IOC) will be met when: NPOESS satellites are operational in two different orbital planes; the EDR attributes associated with those two orbital planes are satisfied; all Centrals are receiving processed data; field terminal software is available; all ground segment elements required to operate all

future production satellites have been delivered, tested, and certified ready for operations; sufficient crews are trained to allow 24 hours/day, 365 days/year operations at the primary MMC, and to allow backup operations as needed; sufficient sustaining engineering resources are in place to allow for anomaly resolution, for example; sufficient logistics resources are in place to support C3, data recovery, and the IDPS; and approval to operate at Schriever AFB is received. The System full operational capability (FOC) will be met when: sufficient satellites are on orbit to satisfy NPOESS TRD key performance requirements, including revisit criteria; sufficient C3 and mission data recovery resources are available; sufficient crews are trained; and sufficient logistics resources are in place to support C3S, data recovery, and IDPS operations.

3.1.6.3.2.1 Risk Reduction Phase

During the risk reduction phase, NPP mission data will be analyzed by the NPP and NPOESS teams to verify algorithms and performance of the instruments. NPP data will be made available to the NPP Centrals to support evaluation and incorporation of selected pre-operational NPOESS EDRs into the Centrals' weather forecasting and modeling systems. During this phase, the NPOESS C3S and IDPS segments will also be responsible for meeting NPP data availability requirements in order to support NASA's NPP objective of providing continuity of climate data measurements between the EOS and NPOESS missions.

3.1.6.3.3 On-orbit Operations

3.1.6.3.3.1 Space Segment

The satellites continuously perform required measurements using the on-board sensors and support the ADCS and SARSAT sensors. Real-time data are continuously broadcast so that users within the field of view may receive the data. The satellites receive commands from the ground for either execution in real time or for subsequent on-board execution.

3.1.6.3.3.2 C3 Segment

The C3S will route data to the appropriate Centrals' IDPS elements. This includes data from both the NPOESS and NPP satellites. Any METOP data required to support the production of the mid-morning orbit NPOESS xDRs , which is available under future international agreements, will also have to be routed to the appropriate NPOESS processing center(s). Routing of NPOESS Data from the NESDIS/NCEP node to EUMETSAT facilities is not the responsibility of NPOESS.

Satellite Control Authority (SCA) is the authority to direct, approve, or delegate satellite command and control. This authority will reside with the primary MMC. The backup MMC will assume SCA in the event of a failure at the primary MMC, or during any other scenario as directed by the IPO (e.g., preventive maintenance activities).

3.1.6.3.3.2.1 DELETED

3.1.6.3.3.3 IDP Segment

The IDP segment will receive satellite mission data, organize that data as required to produce RDRs, and process it, into EDRs. The IDP segment may also use ancillary data in the processing. IDPS processing will also generate other sensor data files commonly known as Sensor Data Records (SDRs) and Temperature Data Records (TDRs). SDRs/TDRs associated with imagery and sounding EDRs are used for near term display, for retrospective processing to develop improved processing methods, or for archival to support long-term sensor evaluation or troubleshooting. This data is also vital when validating the data, determining data quality, and in data quality resolution. SDR intermediate-level data needs to be available as separate and selectable data records for user displays. Throughout this document, production of EDRs includes production of intermediate-level processed data files, as needed. Appendix E lists the delivery destinations of NPOESS and NPP data products. See Appendix A for definition of terms.

3.1.7 Missions

The mission of NPOESS is to provide an enduring and survivable capability which supports user requirements through all levels of conflict consistent with the survivability of the supported forces, to collect and disseminate global meteorological, oceanographic, climatological, and solar-geophysical data required to support worldwide DoD and civilian operations and high-priority programs. A secondary mission is to provide search and rescue (SARSAT) capabilities.

The NPP mission is to be a bridge between the existing Earth Observation System and the NPOESS program. The mission provides continuity of climate data measurements for NASA and risk reduction for NPOESS. For NASA, NPP will provide extended observations for key sustained measurements identified in the EOS Science Plan. For the IPO, NPP provides an opportunity to demonstrate new instruments, algorithms, and pre-operational ground systems. For the users, it will allow them to develop techniques to utilize fully the new data to be provided by NPOESS.

3.1.8 Threat

[Not applicable to NPP.]
The System is subject to the threat described in Section 3.2.1.11.

3.2 SYSTEM CHARACTERISTICS

Requirements that are known to be applicable only to a single segment or to a single prime Configuration Item (CI), such as the satellite, are stated in the appropriate paragraph in Subsection 3.7 and not in this subsection.

3.2.1 Performance Characteristics

3.2.1.1 Performance Requirements for Each System Mode

TRD3.2.1.1-1
The System and/or satellite shall be able to separately command any sensor suite into any sensor mode.

TRD3.2.1.1-2
In all system modes (Normal Operations, Selective Data Encryption, and Upgrade), the System shall provide the users with RDRs, SDRs/TDRs, and EDRs processed to the performance specification in Appendix D. [Selective Data Encryption Not Applicable to NPP]

TRD3.2.1.1-3
In the Selective Data Encryption Mode, the System shall have the capability to deny sensor data in any or all downlinks, except for the SARSAT and ADCS payload downlinks. [Not Applicable to NPP]

TRD3.2.1.1-4
In the Selective Data Encryption Mode, the System shall have the capability to deny real time transmission of sensor data over selected regions of the globe, except for the SARSAT and ADCS payload downlinks. [Not Applicable to NPP]

TRD3.2.1.1-5
In the System Upgrade Mode, the System shall support Normal Operations plus all activities involved with a given system upgrade.

TRD3.2.1.1-6
During times of national emergency, as determined by the National Command Authority, the NCA will notify the appropriate Government personnel that the NPOESS system must be placed in a selective data encryption mode. The system shall go into the selective data encryption mode upon receipt of a ground command from the MMC. [Not applicable to NPP.]

TRD3.2.1.1-7
During times of national emergency, the System shall have the capability to command the satellite in accordance with National Command Authority (NCA) tasking. [NPP only]

TRD3.2.1.1-8
In all System Modes, the satellite shall maintain the ability to broadcast real-time and stored mission data, except as noted in TRD3.2.1.1-9. [Not applicable to NPP.]

TRD3.2.1.1-9
After entering the Selective Data Encryption Mode under the conditions stipulated in TRD3.2.1.9-4, the satellite shall maintain the ability to broadcast real-time (threshold) and stored (objective) mission data with a mapping accuracy threshold of at least 45 km ($\leq$ 1 km objective). [Not applicable to NPP.]

TRD3.2.1.1-10
The system shall maintain a historical record of autonomous events to the extent necessary to enable reconstruction of the decisions made and methods used by the satellite while performing in an anomalous state. [Not applicable to NPP.]

TRD3.2.1.1-11
The system shall provide the ability to command/override each satellite into any of the system modes or states. [Not applicable to NPP.]

3.2.1.2 Data Latency and Availability

EDR latency is defined as the period from the Time of Observation of all requisite data by the satellite until the EDR produced by that data is available at the IDPS/Central interface. The interface boundary for data latency timing notionally is at the IDPS output port. Details will be specified in the external ICD.

TRD3.2.1.2-1 DELETED

TRD3.2.1.2-2
The system shall make all NPP sensor and spacecraft telemetry available to the SDS in engineering units within 180 minutes of generation on the spacecraft. [NPP only]

3.2.1.2.1 Data Availability to the Centrals

TRD3.2.1.2.1-1
The mission data (sensor dependent) shall be provided to the Centrals as shown in Appendix E.

TRD3.2.1.2.1-2 DELETED

TRD3.2.1.2.1-3 DELETED

TRD3.2.1.2.1-4
On a monthly basis, the system shall provide to the Centrals 99%/100% (threshold/objective) of the data collected by operational sensors on each satellite. [Not applicable to NPP.]

TRD3.2.1.2.1-5
The system shall provide the data in TRD3.2.1.2.1-4 within the EDR latency specified in Appendix D, 95%/100% (threshold/objective) of the time (on a monthly average). [Not applicable to NPP.]

TRD3.2.1.2.1-6
In a missed contact scenario, NPOESS data shall be recovered on subsequent contacts in accordance with TRD3.2.1.2.1-4. [Not Applicable to NPP.]

TRD3.2.1.2.1-7
Recovery of missed data shall not impact the delivery of data that can still meet EDR latency requirements. [Not applicable to NPP.]

TRD3.2.1.2.1-8
The satellite shall store data at the horizontal spatial resolution output by the individual sensor. [Not applicable to NPP.]

TRD3.2.1.2.1-9
If data compression techniques are used in Stored Mission Data transmissions, the compression shall be lossless.

TRD3.2.1.2.1-10
The Stored Mission Data (SMD) delivered to the Centrals shall not be degraded from the resolution at which it was stored on the satellite.

TRD3.2.1.2.1-11
On an annual basis, the system shall make 98%/100% (threshold/objective) of the observable NPP mission data available to the NPP Centrals, SDS, and ADS. [NPP only] (Assume the NPP satellite transmits 100% of the observable data.)

TRD3.2.1.2.1-12 DELETED

TRD3.2.1.2.1-13
The system shall make NPP mission data available to the NPP Centrals within 180 minutes from time of observation of all requisite data needed to produce the EDRs specified in Appendix D, at least 95% of the time, over an annualized basis. [NPP only] (Assume the NPP satellite transmits 100% of the observable data.)

TRD3.2.1.2.1-14
In a missed contact scenario, NPP data shall be recovered on subsequent contacts in accordance with TRD3.2.1.2.1-11. [NPP only]

3.2.1.2.1.1 DELETED

TRD3.2.1.2.1.1-1 DELETED

3.2.1.2.2 Data Availability to Field Terminals

The Field Terminals are comprised of two types: high rate data (HRD) and low rate data (LRD). [Not applicable to NPP.]

TRD3.2.1.2.2-1 DELETED

TRD3.2.1.2.2-2
The satellite shall be capable of transmitting HRD/LRD mission data continuously in real time for acquisition by suitably equipped HRD/LRD field terminals. [Not applicable to NPP.]

TRD3.2.1.2.2-3 DELETED

TRD3.2.1.2.2-4 DELETED

TRD3.2.1.2.2-5 DELETED

TRD3.2.1.2.2-6
The system shall have the capability to command the NPP satellite to broadcast real-time high rate data continuously to field terminals. [NPP only]

3.2.1.2.2.1 High Rate Data (HRD)

TRD3.2.1.2.2.1-1
The high rate mission data delivered to the HRD Field Terminal shall contain the mission data specified in Appendix E, Table 50.1.1. [Not applicable to NPP.]

TRD3.2.1.2.2.1-2
The mission data delivered to the HRD field terminals shall not be degraded from the resolution at which the data was stored on the satellite. [Not Applicable to NPP.]

TRD3.2.1.2.2.1-3
If data compression techniques are used in High Rate Data transmissions, the compression shall be lossless. [Not Applicable to NPP.]

TRD3.2.1.2.2.1-4
The System shall have the capability of forwarding a Direct Mode Data Message from the MMC to HRD recipients. [Not applicable to NPP.]

TRD3.2.1.2.2.1-5
The system shall be capable of selecting via ground-based commanding, the Application Packet Identifiers (APID) required to produce all HRD EDRs in Appendix E, Table 50.1.1. [Not applicable to NPP.]

TRD3.2.1.2.2.1-6
The System shall always make ADCS data available to HRD recipients. [Not applicable to NPP.]

3.2.1.2.2.2 Low Rate Data (LRD)

TRD3.2.1.2.2.2-1
The mission data delivered to the LRD Field Terminal shall contain the mission data specified in Appendix E, Table 50.1.2. [Not applicable to NPP.]

TRD3.2.1.2.2.2-2
In order to optimize the content of the LRD downlink and EDR performance, the system shall support the production of the 8 high priority EDRs listed in Appendix E, Table 50.1.2 at a compromised quality level (threshold); and support the production of all EDRs at the SMD threshold quality level (objective). A compromised quality level may include EDRs at reduced resolution, or with the use of lossy compression techniques. [Not applicable to NPP.]

TRD3.2.1.2.2.2-3
The system shall be capable of selecting, via ground-based commanding, the Application Packet Identifiers (APID) required to produce all EDRs in Appendix E, Table 50.1.2 (threshold), and the APIDs from all instruments except OMPS, SESS, and ERBS (objective). [Not applicable to NPP.]

TRD3.2.1.2.2.2-4
The System shall have the capability of forwarding a Direct Mode Data Message from the MMC to LRD recipients. [Not applicable to NPP.]
TRD3.2.1.2.2.2-5 DELETED

3.2.1.3 DELETED

TRD3.2.1.3-1 DELETEDTRD3.2.1.3-2 DELETEDTRD3.2.1.3-3 DELETEDTRD3.2.1.3-4 DELETEDTRD3.2.1.3-5 DELETEDTRD3.2.1.3-6 DELETEDTRD3.2.1.3-7 DELETEDTRD3.2.1.3-8 DELETED

3.2.1.4 Orbit Adjustment Capability

TRD3.2.1.4-1
The System shall maintain the precise orbit altitude, inclination, and nodal crossing times specified in paragraph 3.7.1.1 while in the normal operational and selective data encryption modes throughout the mission lifetime. [Not applicable to NPP.]

TRD3.2.1.4-2
The System shall maintain a ground track repeat for those EDRs that require a precise ground track. [Not applicable to NPP.]

TRD3.2.1.4-3
The System shall provide the same satellite functional capabilities during (objective) and after (threshold) an orbit adjustment maneuver as were available prior to the maneuver.

TRD3.2.1.4-4
Each NPOESS satellite shall be designed to prevent damage or contamination of on-board sensors and subsystems due to delta-V thrust applications during an orbit adjustment maneuver. [Not applicable to NPP.]

TRD3.2.1.4-5
C3 segment commanding shall maintain the NPP satellite in the precise orbit specified in paragraph 3.7.1.1. [NPP ONLY]

TRD3.2.1.4-6
C3 segment commanding shall maintain the NPP satellite's crosstrack groundtrack repeat to +/- 20 km over 16 (TBR) days at all latitudes. [NPP ONLY]

3.2.1.5 Advanced Data Collection System (ADCS)

[Not applicable to NPP.]

The NPOESS Space Segment will incorporate an Advanced Data Collection System (ADCS) transponder (e.g., ARGOS-3) which is provided GFE (with the exception of the antennas and cables). The ARGOS system is an international surface data collection system which is managed by France. The transponder receives randomly distributed uplink signals at 401.650 MHz from up to 5600 Data Collection Platforms (DCPs) deployed worldwide, approximately 1660 of which are within the transponder's instantaneous field of view. The instrument will also receive "messages" uplinked from remote ground stations called "Master Beacons", store these messages in its on board memory banks, and then forward these messages to Platform Message Terminals (PMTs) within the transponder's instantaneous field of view via its internal transmitter, at 465.9875 MHz. The data from the DCPs and doppler-processed location information is transmitted in real time via the HRD broadcast. This data is also stored on-board the satellite and will be transmitted as part of the stored mission data to the Central site at NESDIS which will in turn, relay the data to the processing center in Largo, MD.

TRD3.2.1.5-1 DELETED

TRD3.2.1.5-2
The System shall continuously transmit ADCS mission data in real-time via the HRD link. Formats shall be (*TBS*). [Not applicable to NPP.]

TRD3.2.1.5-3
The System shall store ADCS data for transmittal as part of the SMD, in formats (TBS). [Not applicable to NPP.]

TRD3.2.1.5-4 DELETED

TRD3.2.1.5-5
The System shall support an unencrypted, non-deniable real-time ADCS forward messaging capability to PMT's within the satellite's field of view. These messages are uplinked from Master Beacons, stored on board in the ADCS, and then transmitted to the PMTs by the ADCS. [Not applicable to NPP.]

TRD3.2.1.5-6
The NPOESS System shall have the capability to provide ADCS in the 1330 and 1730 orbits. (The 2130 orbit will be fulfilled by METOP.) [Not applicable to NPP.]

TRD3.2.1.5-7 DELETED

3.2.1.6 Search and Rescue (SARSAT) Capability

[Not applicable to NPP.]

The NPOESS Space Segment will incorporate Search and Rescue Satellite Aided Tracking (SARSAT) instruments which are provided GFE (with the exception of the antennas). The Search and Rescue Repeater (SARR) receives uplink signals at 406.05 MHz from emergency beacons (ELT, EPIRB, and PLB) within the field of view of the satellite. The transmissions at 406.05 MHz are also processed by the Search and Rescue Processor (SARP), which measures the frequency and extracts the transmitted message, then stores this information together with the time of reception in the SARP-M circular memory. This stored information is then retrieved in near real-time (depending on the commanded mode of the SARP) and formed into the SARP 2.4 kbps data stream. The SARP data stream is interleaved with the translated output from the SARR and transmitted in real-time at 1544.5 MHz to any SARSAT local user terminals (LUT) within the satellite's field of view. These data are forwarded to the COSPAS/SARSAT Mission Control Centers (MCC). Additionally, the telemetry from the SARR and SARP instruments is provided from the NESDIS/NCEP Central to the U.S. MCC. The MCCs distribute the data to the international search and rescue forces. The SARSAT system is part of the COSPAS-SARSAT international search and rescue system which is managed by representatives of the U.S., Canada, France, and Russia. The SARSAT beacons and LUTs will be supplied, implemented, operated, and maintained by local authorities.

The NPOESS Program will be compatible with DOC’s international agreements, COSPAS / SARSAT agreement, (1 Jul 1988, as amended) for search and rescue.

TRD3.2.1.6-1 DELETED

TRD3.2.1.6-2 DELETED

TRD3.2.1.6-3
The NPOESS System shall have the capability to provide SARSAT functions in all 3 orbits. [Not applicable to NPP.]

TRD3.2.1.6-4
The System shall not alter the data or the waveform that is transmitted between the SARSAT sensor and a SARSAT LUT. [Not applicable to NPP.]

3.2.1.7 Mission Planning Capability

TRD3.2.1.7-1
The System shall perform the mission planning required to, as a minimum, schedule system resources, make mission, ADCS, SARSAT, and telemetry data available for distribution, provide pass plans to users, and coordinate mission events with European agencies, as required. [Not applicable to NPP.]

3.2.1.8 Sensor Calibration

TRD3.2.1.8-1
The System shall perform periodic autonomous or ground controlled mission sensor calibration to maintain compliance with data product performance in Appendix D.

TRD3.2.1.8-2
The system shall perform trend analyses on sensor performance parameters to verify Appendix D stability requirements are maintained over time.

TRD3.2.1.8-3
For the climatology mission, the contractor shall deliver records of sensor calibration changes per Appendix D requirement TRD40.1.8.

3.2.1.9 Data Access

[Not applicable to NPP.]

Mission data access (deniability) is a key performance parameter.

TRD3.2.1.9-1
Under normal conditions, NPOESS HRD and LRD downlinks shall be unencrypted. [Not applicable to NPP.]

TRD3.2.1.9-2
The System shall always provide unencrypted, non-deniable real-time ADCS data via the HRD downlink. [Not applicable to NPP.]

TRD3.2.1.9-3
The System shall always provide an unencrypted SARSAT data downlink. [Not applicable to NPP.]

TRD3.2.1.9-4
Each satellite shall automatically transition to selective data encryption mode after ground contact has not occurred for a period of time determined by a loadable table. [Not applicable to NPP.]

TRD3.2.1.9-5
After entering the Selective Data Encryption Mode under the conditions stipulated in TRD3.2.1.9-4, the satellite shall have the capability to remain in that mode for 21/60 days (threshold/objective), without additional commands from the ground. [Not applicable to NPP.]

3.2.1.10 Satellite External and Built-in Testing

TRD3.2.1.10-1
The System shall have the capability of externally testing each satellite, while in storage and on the launch pad, to verify its functional and operational readiness. Components that must be cold to operate properly are not subject to external testing on the launch pad. [Not applicable to NPP.]

TRD3.2.1.10-2
Each satellite shall have the capability of accomplishing self-testing using built-in test (BIT) functions to determine its state of health. [Not applicable to NPP.]

3.2.1.11 System Threat

[Not applicable to NPP.]

NPOESS threats are discussed in the following classified references: Space Systems Threat Environment Description (TED) and the Defense Meteorological Satellite Program (DMSP) / National Polar-Orbiting Operational Environmental Satellite System (NPOESS) System Threat Assessment Report (STAR).

TRD3.2.1.11-1
The system shall comply with the NPOESS threat mitigation and survivability requirements contained in the classified Appendix B. [Not applicable to NPP.]

TRD3.2.1.11-2
The system shall monitor the operational threat environment identified in the classified Appendix B. [Not applicable to NPP.]

TRD3.2.1.11-3
The system shall accommodate a survivability suite which responds to the threats identified in Appendix B. [Not applicable to NPP.]

TRD3.2.1.11-4
The system shall report all detected attacks to appropriate agencies via communication methods and timelines specified in Appendix B. [Not applicable to NPP.]

3.2.2 System Capability Relationships

3.2.2.1 Reference Timelines

Reference timelines can be derived from the Latency, Revisit, and Refresh requirements defined elsewhere in this document. (See 3.2.1.2 and Appendix D)

3.2.3 Interface Requirements

3.2.3.1 External Interface Requirements

The following subparagraphs describe the requirements for interfaces between NPOESS and other systems.

3.2.3.1.1 External Interface to Centrals

As a goal, all external interfaces from the system should have a common format.

TRD3.2.3.1.1-1
NPOESS hardware shall interface with its host facility for floor space, power, lighting, air-conditioning, security, and access to communications networks. The contractor should provide a preliminary estimate of requirements for space (both square footage of floor space and volumetric - especially required are volume and dimensions below floor and head room above raised floor), and power requirements (power factor, peak load, etc.).

TRD3.2.3.1.1-2 DELETED

TRD3.2.3.1.1-3
The system shall make EDRs available to Centrals as specified in Appendix E as well as RDRs/SDRs/TDRs for each sensor.

TRD3.2.3.1.1-4
The system shall have the capability to respond to data requests from Centrals.

TRD3.2.3.1.1-5
The system shall have the capability to receive ancillary data.

TRD3.2.3.1.1-6 DELETED

TRD3.2.3.1.1-7 DELETED

TRD3.2.3.1.1-8 DELETED

TRD3.2.3.1.1-9
There shall be at least one DOC and one DoD IDPS to meet the respective mission requirements of each Department.

TRD3.2.3.1.1-10 DELETED

TRD3.2.3.1.1-11 DELETED

TRD3.2.3.1.1-12
The system located at the NESDIS/NCEP Central shall make ADCS data and its telemetry available to NESDIS. (Transfer of data to the ARGOS U.S. processing center is a government function.) [Not applicable to NPP.]

TRD3.2.3.1.1-13 DELETED

TRD3.2.3.1.1-14
The system located at the NESDIS/NCEP Central shall make SARSAT supporting data available to NESDIS. (Transfer of data to the SARSAT U.S. Mission Control Center (MCC) is a government function.) [Not applicable to NPP.]

3.2.3.1.2 External Interface to DoD/DOC Field Terminals

[Not applicable to NPP.]

The field terminal software is the NPOESS EDR processing software. The implementation, configuration, operation, and maintenance of the field terminals are the responsibilities of the Services, DOC, and the civil community. The NPOESS responsibility is to deliver the NPOESS sensor information in a RF stream to an antenna and then to process the digital data stream into NPOESS products using the NPOESS provided and maintained software.

Thus, there are three interfaces between NPOESS elements and the Field Terminals:

a) the interface between the NPOESS HRD or LRD RF stream and the field terminal antenna/receiver equipment,
b) the interface between the field terminal signal processing unit and the field terminal software, and
c) the interface where NPOESS products from the field terminal software are made available to the field terminal/user equipment (e.g., software, network computer terminals, display monitors, and servers hosting databases of ancillary data received independently of NPOESS).

TRD3.2.3.1.2-1
The field terminal segment shall provide the capability to generate the EDRs specified in Appendix E and make them available to the Field Terminal/user equipment. [Not applicable to NPP.]

TRD3.2.3.1.2-2
The field terminal segment shall have the capability to receive ancillary data needed for EDR generation. [Not applicable to NPP.]

TRD3.2.3.1.2-3 DELETED

3.2.3.1.2.1 External Interfaces to Field Terminal Receiver Equipment

TRD3.2.3.1.2.1-1 DELETED

TRD3.2.3.1.2.1-2
The EMD contractor shall define the RF interface to the field terminals for both the HRD and LRD links. [Not Applicable to NPP.]

3.2.3.1.3 DELETED

3.2.3.1.4 DELETED

3.2.3.1.5 DELETED

TRD3.2.3.1.5-1 DELETED

3.2.3.1.6 External Interface to Search and Rescue System

TRD3.2.3.1.6-1 DELETED

TRD3.2.3.1.6-2 DELETED

TRD3.2.3.1.6-3 DELETED

TRD3.2.3.1.6-4
The Space Segment shall interface to the SARSAT equipment [Search and Rescue Processor (SARP-3) and Search and Rescue Repeater (SARR)]. For information purposes, the POES Unique Interface Specifications for the SARP-3 and SARR are referenced in Section 2.3. [Not applicable to NPP.]

TRD3.2.3.1.6-5
The Space Segment shall include an antenna capable of receiving 406.01 - 406.09 MHz emergency beacon data. [Not applicable to NPP.]

TRD3.2.3.1.6-6
The Space Segment shall include an antenna capable of rebroadcasting the SARSAT data via the Search and Rescue Repeater (SARR) at 1544.5 MHz to any SARSAT LUTs within the satellite's field of view. [Not applicable to NPP.]

TRD3.2.3.1.6-7
The Space Segment shall continuously receive and transmit search and rescue data to SARSAT terminals within the satellite's field of view. [Not applicable to NPP.]

TRD3.2.3.1.6-8 DELETED

3.2.3.1.7 External Interface to Advanced Data Collection System (ADCS)

The top level NPOESS requirements for the ADCS external interface are described in Section 3.2.1.5.

TRD3.2.3.1.7-1 DELETED

TRD3.2.3.1.7-2 DELETED

TRD3.2.3.1.7-3 DELETED

TRD3.2.3.1.7-4
The Space Segment shall interface to the ADCS equipment. For information purposes, the POES Unique Instrument Interface Specification for the Advanced Data Collection and Location System (ADCS) and the ARGOS-3 System Technical Specification are referenced in Section 2.3. [Not applicable to NPP.]

TRD3.2.3.1.7-5
The Space Segment shall include an antenna capable of receiving ADCS (or follow-on) Platform data. [Not applicable to NPP.]

TRD3.2.3.1.7-6
The Space Segment shall provide an antenna capable of transmitting ADCS forward messaging data to suitably equipped ADCS PMTs. [Not applicable to NPP.]

TRD3.2.3.1.7-7
The Space Segment shall receive and transmit ADCS data within the satellite's field of view. [Not applicable to NPP.]

TRD3.2.3.1.7-8
The EMD contractor shall comply with the RF interface (TBD) to the ADCS PMTs. [Not Applicable to NPP.]

3.2.3.1.8 External Interface to Launch Vehicle

The LSS should be coordinated with the Launch Vehicle (LV) contractor for scheduling, status, and launch support at the launch base.

TRD3.2.3.1.8-1
During the pre-separation phase, the System shall provide positive inhibits for execution of any stored program commands which have safety implications. [Not applicable to NPP.]

TRD3.2.3.1.8-2
The NPOESS satellite shall comply with the EELV Standard Interface Specification as modified by an Interface Control Document negotiated with the specific Launch Service contractor. [Not applicable to NPP.]

TRD3.2.3.1.8-3
A single NPOESS satellite shall not exceed an EELV "medium class" launch vehicle capability as referenced in the Evolved Expendable Launch Vehicle Standard Interface Specification. [Not applicable to NPP.]

3.2.3.1.9 External Interface to Launch Site

The LSS should be coordinated with the appropriate US Government personnel to arrange for the use of the launch facilities and their equipment for satellite processing. [Not applicable to NPP.]

TRD3.2.3.1.9-1
The LSS shall interface with the appropriate range and launch control facilities for launch operations. [Not applicable to NPP.]

TRD3.2.3.1.9-2
The extent of the interface with the appropriate range shall be to verify compliance with the applicable Range Safety Requirements of EWR 127-1, including ground monitoring functions. [Applicable, as necessary (e.g., sensors) for NPP.]

3.2.3.1.10 External Interface to NORAD

TRD3.2.3.1.10-1
After the launch of satellites, the system shall support requests to NORAD and receipt from NORAD of ELSETs for orbit determination whenever any satellite's own orbit determination capability is not operational.

3.2.3.1.11 External Interface to MMC's Host Facility

3.2.3.1.11.1 External Interface to Primary MMC's Host Facility

TRD3.2.3.1.11.1-1
The NPOESS primary MMC shall interface with its host facility for floor space, power, lighting, air-conditioning, security, and access to communications networks.

3.2.3.1.11.2 External Interface to Backup MMC

TRD3.2.3.1.11.2-1
The NPOESS backup MMC shall interface with its host facility for floor space, power, lighting, air-conditioning, security, and access to communications networks.

3.2.3.1.11.3 DELETED

TRD3.2.3.1.11.3-1 DELETED

TRD3.2.3.1.11.3-2 DELETED

TRD3.2.3.1.11.3-3 DELETED

TRD3.2.3.1.11.3-4 DELETED

TRD3.2.3.1.11.3-5 DELETED

TRD3.2.3.1.11.3-6 DELETED

3.2.3.1.12 External Interface to Shared Resources

Depending on the C3 concept, the System will interface on a shared basis with the facilities at NOAA CDAs that have dedicated NPOESS antennas, commercial data acquisition sites and/or real time data relay sites (such as TDRSS).

3.2.3.1.12.1 External Interface to NOAA CDAs

TRD3.2.3.1.12.1-1
If the proposed C^3 architecture utilizes NOAA CDA shared resources, NPOESS Space Segment and/or C^3 equipment shall interface with shared facility resources at applicable NOAA CDAs.

3.2.3.1.12.2 External Interface to METOP Ground Stations

[Not applicable to NPP.]

TRD3.2.3.1.12.2-1
If the proposed C^3 architecture utilizes METOP ground station shared resources, NPOESS Space Segment and/or C^3 equipment shall interface with shared resources at applicable METOP ground stations. [Not applicable to NPP.]

TRD3.2.3.1.12.2-2
If data from METOP satellites is required to meet the requirements of this TRD, the NPOESS DRR architecture and costs shall include the relaying of that data to the NPOESS CONUS processing facilities as required. The current

interface is between the EUMETSAT Core Ground Station (CGS) in Darmstadt, Germany and the NOAA node at NESDIS/NCEP. Other interfaces may be evaluated. [Not applicable to NPP.]

3.2.3.1.12.3 External Interface to Commercial Command Data Acquisition Stations

TRD3.2.3.1.12.3-1
If the proposed C^3 architecture utilizes commercial CDA shared resources, NPOESS Space Segment and/or C^3 equipment shall interface with shared resources at applicable commercial command data acquisition sites.

3.2.3.1.12.4 External Interface to Real Time Data Relay Systems (TBD)

TRD3.2.3.1.12.4-1
If the proposed C^3 architecture utilizes real time data relay systems, NPOESS Space Segment and/or C^3 equipment shall interface with shared resources at applicable command data acquisition sites.

3.2.3.1.13 External Interface to Support Facilities for LEO&A *(TBR)*

The National Telecommunications and Information Administration (NTIA) has granted NPOESS access to those portions of the S-band (USB) required to support this LEO&A mission. During Launch, Early Orbit, and Anomaly (LEO&A) emergencies, NPOESS should be capable of interfacing with the NASA SN and other support facilities, as well as NOAA CDA sites.

TRD3.2.3.1.13-1
To support LEO&A, emergencies, and NPP calibration maneuvers, the System shall have the capability to transmit a command uplink and telemetry downlink that is compatible with USB sites per Table 1 of Appendix C and the NASA SN LEO&A support per Table 6 of Appendix C.

TRD3.2.3.1.13-2 DELETED

3.2.3.1.14 FVS External Interface to Host Facility

TRD3.2.3.1.14-1
Each FVS shall interface with its host facility for floor space, power, lighting, air conditioning, security, and access to communications networks.

3.2.3.1.15 External Interface to NPP

TRD3.2.3.1.15-1
NPOESS C^3 equipment shall interface with NPP per the data links described in Appendix C.

TRD3.2.3.1.15-2
The C3S shall interface with the NPP LSS in order to perform required C3 operations during pre-launch operations. [NPP only]

TRD3.2.3.1.15-3
The NPOESS system located at NESDIS/NCEP shall make RDRs and associated metadata available to the NPP Science Data Segment (SDS). (Details will be specified in the external ICD. Transfer of data to the NPP SDS is a government function.) [NPP only]

3.2.3.1.16 DELETED

3.2.3.1.17 External Interface from IDPS to Long Term Archives

TRD3.2.3.1.17-1
The NPOESS system located at NESDIS/NCEP shall make data available to the long-term data archive. The portion of the long-term archive for NPP is called the NPP Archive and Distribution Segment (ADS). (Transfer of data to the long-term data archive is a government function.)

3.2.3.2 Inter-Segment Interface Requirements

The following subparagraphs describe the requirements for the interfaces between the NPOESS segments.

3.2.3.2.1 Space Segment to DoD/DOC Field Terminal

TRD3.2.3.2.1-1 DELETED

TRD3.2.3.2.1-2
The communication links between the SS and the DoD/DOC Field Terminal element shall provide the capability to mitigate (TBR) intentional interference to the data. [Not applicable to NPP.]

TRD3.2.3.2.1-3
The HRD and LRD communication links between the SS and the DoD/DOC Field Terminal element shall comply with the NPOESS link characteristics specified in Appendix C. [Not applicable to NPP.]

TRD3.2.3.2.1-4
All raw data packet headers shall contain a UTC time reference, associated to the time of the event measured, derived from GPS or equivalent.

TRD3.2.3.2.1-5
The system shall have the capability to periodically monitor the content and quality of the HRD and LRD links. [LRD Link Not Applicable to NPP.]

3.2.3.2.1.1 High Rate Data (HRD) Broadcast Interface

TRD3.2.3.2.1.1-1
The HRD broadcast link shall meet the requirements described in Appendix C. [Not applicable to NPP.]

TRD3.2.3.2.1.1-2 DELETED

3.2.3.2.1.2 Low Rate Data (LRD) Broadcast Interface

TRD3.2.3.2.1.2-1
The LRD broadcast link shall meet the requirements described in Appendix C. [Not applicable to NPP.]

3.2.3.2.1.3 DELETED

TRD3.2.3.2.1.3-1 DELETED

3.2.3.2.2 Space Segment to/from C3 Segment

TRD3.2.3.2.2-1 DELETED

TRD3.2.3.2.2-2
All links between the C3 Segment and the NPOESS Space Segment shall preclude unauthorized contact. [Not applicable to NPP.]

TRD3.2.3.2.2-3
All uplinks and downlinks shall comply with the link characteristics specified in Appendix C.

TRD3.2.3.2.2-4
The command links between the C3 Segment and the NPP Space Segment shall preclude unauthorized contact.

3.2.3.2.2.1 Stored Mission Data Downlink Interface

TRD3.2.3.2.2.1-1
The SMD downlink shall include mission data, ADCS, and stored telemetry data. [ADCS data is not applicable to NPP]

TRD3.2.3.2.2.1-2
All raw data packet headers shall contain a UTC time reference derived from GPS or equivalent.

3.2.3.2.2.2 Command Uplink Interface

TRD3.2.3.2.2.2-1
The System shall be able to send all commands and memory uploads required by the satellite onboard processors.

TRD3.2.3.2.2.2-2 DELETED

TRD3.2.3.2.2.2-3
The System shall be able to successfully command the satellite in any orientation of the satellite, including tumbling conditions.

3.2.3.2.2.3 Real-time Telemetry Downlink Interface

TRD3.2.3.2.2.3-1
The Space Segment shall have the capability to transmit real-time telemetry data continuously. [Not applicable to NPP.]

TRD3.2.3.2.2.3-2
The Space Segment shall be able to transmit real-time telemetry in any spacecraft orientation, including a tumbling state. [Not applicable to NPP.]

TRD3.2.3.2.2.3-3
The C3 Segment shall be capable of receiving real-time telemetry from the NPP satellite via the space network.

TRD3.2.3.2.2.3-4
The C3 Segment shall be capable of receiving real-time telemetry from the satellite, in any satellite orientation, including a tumbling state.

TRD3.2.3.2.2.3-5
The real time telemetry shall be provided to C3S via the S-band (USB).

3.2.3.2.3 C3 Segment to/from the Interface Data Processor Segment

TRD3.2.3.2.3-1
The C3 Segment shall interface with the IDPS via data links with sufficient capacity to handle all satellite transmissions to meet EDR latency.

TRD3.2.3.2.3-2
The System shall have the capability to route information, as necessary, between the IDPS and the C3 Segment.

3.2.3.2.4 C3 Segment to Launch Support Segment

TRD3.2.3.2.4-1
The C3S shall have the capability to perform required C3 operations during pre-launch operations, e.g., integration and test support, mission operations rehearsals, pre-launch exercises, and launch operations. [Not applicable to NPP.]

3.2.3.2.5 Space Segment to Launch Support Segment

TRD3.2.3.2.5-1
The LSS shall provide the capability to interface with the satellite to support pre-launch operations. [Not applicable to NPP].

TRD3.2.3.2.5-2
The LSS shall have the capability to command and monitor the health and status of the satellite during launch operations until the moment of launch. [Not applicable to NPP].

TRD3.2.3.2.5-3
The LSS shall support access to the satellite for launch processing, servicing, and maintenance. [Not applicable to NPP].

TRD3.2.3.2.5-4 DELETED

3.2.3.3 Infrastructure Support and Interoperability

NPOESS system interfaces should be designed to be interoperable with the systems with which they must communicate. This includes the physical and electrical interfaces with equipment at the Centrals and Field Terminals, and the RF interfaces to various DoD and civilian C^3 nodes. Interoperability includes hardware and software compatibility with communication protocols and formats.

TRD3.2.3.3-1
The installation and operation of NPOESS equipment shall not adversely impact the operational capabilities of the host or existing user systems (DoD/DOC Centrals, CDAs, MMCs, and field elements).

TRD3.2.3.3-2 DELETED

TRD3.2.3.3-3 DELETED

TRD3.2.3.3-4 DELETED

TRD3.2.3.3-5
The NPOESS system shall be interoperable with the systems with which it must communicate (interoperability is a key performance parameter).

TRD3.2.3.3-6
Backup power sources shall be able to provide uninterruptible power for NPOESS equipment for a minimum of 2 hours. [Applies only to Centrals, MMC, and backup MMC.] [Not applicable to NPP.]

TRD3.2.3.3-7
The installation and operation of NPOESS equipment shall not disrupt or degrade the ongoing operations of the host facility.

3.2.3.3.1 Transportation and Basing

TRD3.2.3.3.1-1 DELETED

3.2.3.3.2 Standardization, Interoperability, and Commonality

The NPOESS C3 Segment and IDPS should maximize compatibility with existing systems. See Section 3.3.11.2 for Software Design, Interoperability, and Support.

TRD3.2.3.3.2-1 DELETED

TRD3.2.3.3.2-2
The System shall use CCSDS Type 1 packetization and Grade 2 service for all data streams (except for ADCS master platform forward messaging capability and the Search and Rescue broadcast links).

TRD3.2.3.3.2-3
All NPOESS C3 links shall comply with national and international guidelines (National Telecommunications and Information Administration (NTIA) and International Telecommunications Union (ITU)) for spectrum utilization/sharing per the Certifications of Spectrum Support. [For NPP, NTIA Stage 2 “Certification of Spectrum

Support", Document # 31817/1, 02 March 2001 and for NPOESS, NTIA Stage 2 "Certification of Spectrum Support, August 1999.]

3.2.4 Physical Characteristics

3.2.4.1 Mass Properties

TRD3.2.4.1-1
The mass properties of each NPOESS satellite and its associated flight equipment shall meet the requirements of the Launch Vehicle (LV) with no less than a 2% margin at the final weighing before shipment to the launch facility. [Not applicable to NPP.]

3.2.4.2 Dimensions

TRD3.2.4.2-1
All top level drawings for major Configuration Items, sensors, and segments, as well as any External Interface Control Document, shall contain units in English and metric. Heritage documentation may retain original dimensioning unless revised for the NPOESS program. Regardless of the selection of units, both the primary (as-designed) units and converted units should be shown on all drawings as either Primary/Converted or Primary (Converted).

TRD3.2.4.2-2
The dimensional envelope constraints of the size and shape of the NPOESS satellite shall be based upon a combination of static, dynamic, and thermal conditions encountered during factory assembly, system test, transportation and handling, launch, deployment, and on-orbit operations.

TRD3.2.4.2-3
The satellite or sensor configuration shall prevent any unwanted solar reflections from interfering with environmental data collection.

TRD3.2.4.2-4
The dimensional envelope constraints of the size and shape of the ground-based NPOESS elements shall be based upon a combination of building and transportation constraints during the mission.

TRD3.2.4.2-5 DELETED

TRD3.2.4.2-6 DELETED

TRD3.2.4.2-7
Analysis results produced by existing software tools can be in heritage units.

3.2.4.3 DELETED

3.2.4.3.1 DELETED

TRD3.2.4.3.1-1 DELETED

TRD3.2.4.3.1-2 DELETED

3.2.4.3.2 DELETED

3.2.4.3.3 DELETED

3.2.4.4 Survivability

[Not applicable to NPP.]

The NPOESS System Survivability requirements are contained in Appendix B. See also Section 3.2.1.11, System Threat.

3.2.4.4.1 Interface Data Processor Segment NBC Survivability

[Not applicable to NPP.]

The Interface Data Processor Segment will be integrated into mobile and fixed systems some of which are required to meet Nuclear, Biological, and Chemical (NBC) survivability requirements.

TRD3.2.4.4.1-1 DELETED

3.2.4.5 Endurance

TRD3.2.4.5-1 DELETED

TRD3.2.4.5-2
The on-orbit design life of the satellites, as may be limited by factors such as mechanical wearout, battery life, solar array life, or the exhaustion of expendables, shall be no less than 7 years. [Not applicable to NPP.]

TRD3.2.4.5-3
The satellite shall be capable of an on-orbit design life of 7 years, after being subjected to 8 years of controlled-condition storage, including up to 3 years for intermittent testing. [Applies to entire NPOESS; for NPP, applies only to CrIS and VIIRS]

TRD3.2.4.5-4
The design service life of the NPOESS operational spacecraft and its sensors shall be at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency.

3.2.4.6 DELETED

TRD3.2.4.6-1 DELETED

TRD3.2.4.6-2 DELETED

TRD3.2.4.6-3 DELETED

TRD3.2.4.6-4 DELETED

TRD3.2.4.6-5 DELETED

TRD3.2.4.6-6 DELETED

TRD3.2.4.6-7 DELETED

3.2.5 System Quality Factors

3.2.5.1 System Operational Availability

System Operational Availability (A_O) is defined as an averaged probability that a system is operable and ready to perform its mission over the mission lifetime. The system Operational Availability for NPOESS is a composite value that includes the Command, Control, and Communications Segment (to/from the Space Segment including MMC equipment); a single Space Segment orbital plane; and an IDP system at a single Central site. A Downing Event (DE) is the loss of the ability to deliver an EDR that contains a KPP. A_O is calculated for each orbital plane using the equation shown below:

$$A_0 = \frac{\text{Uptime}}{\text{Total Time}} = \frac{\text{MTBDE}}{\text{MTBDE + MDT}} \text{ X } 100\%$$

where: MTBDE is the Mean Time Between Downing Events, i.e.,

MTBDE = [Number of Operating Hours] / [Number of Downing Events]

and MDT is the Mean Down Time
(time required to restore the system capability to deliver the KPP.), i.e.,

MDT = [Total Down Time] / [Number of Downing Events]

TRD3.2.5.1-1
The A_o of the NPOESS System shall be greater than 93% (threshold), with an objective of 95%, averaged over the mission lifetime for the orbits defined in TRD3.7.1.1-1. [Not applicable to NPP.]

TRD3.2.5.1-2 DELETED

TRD3.2.5.1-3
The A_o of the NPOESS System shall be greater than (TBD)%, averaged over the projected on-orbit life for a single satellite launched into an orbit defined in TRD3.7.1.1-3. [Not applicable to NPP.]

3.2.5.2 Space Segment Availability

The space segment A_o is calculated for an individual orbit plane. If a space segment failure requires launch of a new satellite, the MDT used in the calculation of the threshold A_o for the space segment includes launch call up and satellite activation time. NPOESS should be capable of providing an operational (checked out on orbit) replacement satellite within 90 days of call-up under planned replenishment conditions – i.e., a satellite and government provided launch capability are available. As a threshold, in the event of any launch or on-orbit failure of any NPOESS satellite, the contractor should be capable of providing an operational replacement satellite on orbit within 180 days (90 day objective), regardless of whether the launch had been previously planned. Launch delays due to factors beyond the contractor's control are not included in the calculation of A_o. [Not applicable to NPP.]

TRD3.2.5.2-1
The space segment shall be operational 24 hours per day.

TRD3.2.5.2-2
The NPOESS space segment shall meet an A_o of greater than (*TBD)*. This A_o includes a single, 180-day unplanned replenishment (per orbital plane). The reliability/availability of the METOP satellites will not be included in space segment availability calculations. [Not applicable to NPP.]

TRD3.2.5.2-3 DELETED

TRD3.2.5.2-4 DELETED

TRD3.2.5.2-5 DELETED

TRD3.2.5.2-6
At any time from completing integration and performance verification to the end of the satellite storage period, the satellite shall support a launch event within 60 days of notification (45 days objective). [Not applicable to NPP.]

TRD3.2.5.2-7
As a threshold, an NPOESS satellite shall be capable of being reconfigured for any orbit, launched, and operational on orbit within 180 days (90 days objective) after call-up.

3.2.5.2.1 Space Segment Operational Service Life

TRD3.2.5.2.1-1
The NPOESS space segment shall be designed to support a total mission life of ten years from first launch need date. [Not applicable to NPP.]

3.2.5.2.2 Maintainability

The spacecraft design should include maintainability features to ensure timely replacement or test of spacecraft subsystems or sensors prior to launch. The design should preclude the need to disassemble the spacecraft in order to change or service subsystems.

TRD3.2.5.2.2-1 DELETED

TRD3.2.5.2.2-2
Except for software updates, space-based elements of the System shall not require maintenance or repair on-orbit. [Only applies to CrIS and VIIRS for NPP]

TRD3.2.5.2.2-3
The spacecraft and key sensors shall have no undocumented single-point failures; documentation must show mission impact, backed by trades and analyses. [Applies to entire NPOESS; for NPP, applies only to CrIS and VIIRS]

TRD3.2.5.2.2-4
The system shall provide the capability for automatic switchover to available backup components and/or circuits where failure of an element on-orbit would cause loss of mission or create a catastrophic/critical hazard. [Not applicable to NPP.]

3.2.5.3 C3 Segment Availability

TRD3.2.5.3-1
The A_O of the C3 Segment shall be greater than (TBD). [Not applicable to NPP]

TRD3.2.5.3-2 DELETED

TRD3.2.5.3-3
The C3S shall have no single point of failure for the satellite operation functions required for real-time telemetry and commanding.

TRD3.2.5.3-4
The A_O of the C3 Segment for NPP shall be greater than (TBD). [NPP only]

3.2.5.3.1 Fault Detection and Reporting

TRD3.2.5.3.1-1
The system shall automatically detect single unit failures (percentage TBD) occurring within a C3 segment element to enable achievement of the system and C3 segment availability thresholds.

TRD3.2.5.3.1-2
NPOESS C3 segment operations staff shall be alerted to each failure within 30 seconds of its detection.

TRD3.2.5.3.1-3
The system shall allow operator initiation of fault detection routines.

3.2.5.3.2 Fault Isolation and Repair

Sufficient fault isolation and repair is required to achieve system and segment availability thresholds.

TRD3.2.5.3.2-1 DELETED

TRD3.2.5.3.2-2
Procedures shall enable C3 segment operators to determine the consequences of the C3 segment failure and take appropriate workaround actions to continue operations without loss of mission or data. As a threshold, workaround actions shall occur in time to achieve the system and C3 segment availability thresholds. As an objective, the Ground Equipment with the failed component(s) should be returned to operations prior to the next downlink opportunity.

3.2.5.4 IDPS Availability

TRD3.2.5.4-1
The A_O of the IDPS at each Central shall be greater than *(TBD)*. [Not applicable to NPP]

TRD3.2.5.4-2
The A_O of the IDPS for NPP shall be greater than *(TBD).*

3.2.5.4.1 Fault Detection and Reporting

TRD3.2.5.4.1-1
The system shall automatically detect single unit failures (percentage TBD) occurring within an IDPS element.

TRD3.2.5.4.1-2
IDPS Operations staff shall be alerted to each unit failure within 30 seconds of its detection.

TRD3.2.5.4.1-3
The system shall allow operator initiation of fault detection routines.

3.2.5.4.2 Fault Isolation and Repair

Sufficient fault isolation and repair is required to achieve system and segment availability thresholds.

TRD3.2.5.4.2-1 DELETED

TRD3.2.5.4.2-2
Procedures shall enable IDPS operators to determine the consequences of the IDPS failure and take appropriate workaround actions to continue operations without loss of mission or data. As a threshold, workaround actions shall occur in time to achieve the system and IDPS availability thresholds. As an objective, the Ground Equipment with the failed component(s) should be returned to operations prior to the next downlink opportunity.

3.2.5.5 Additional Quality Factors

Deleted

3.2.5.5.1 System Compatibility

NPOESS capabilities should be configured to be compatible, as appropriate, to meet user needs with minimum impact to existing facilities and procedures.

3.2.5.5.2 Transition

TRD3.2.5.5.2-1
During the transition period, NPOESS shall not interfere with the normal operation of the DMSP and POES Systems, except where shared resource allocation by the Satellite Control Authority results in such interference.

3.2.5.5.3 Shared Processing Program

The Centrals should participate, to the maximum extent possible, in the IDPS operation and algorithm upgrades. While NPOESS is not constrained by the structures of the POES and DMSP programs, it is desirable to emulate and incorporate successful models of cooperation and shared responsibility, such as the Shared Processing Program, into the NPOESS concept of operations.

3.2.6 Environmental Conditions

Segment requirements to allow for the adverse impacts of the natural environment should be derived from space segment design life and/or data availability requirements.

3.2.7 Transportability

TRD3.2.7-1
The satellite(s) and the support equipment that must be transported with the satellite shall be designed for ground and air transportation in accordance with best commercial or military practices.

3.2.8 Flexibility and Expansion

System flexibility and expansion should be provided by the System design and architecture. Base resource requirements are to be validated at the appropriate segment CDR, and will comprise the projected capacity (memory, storage, processing speed, LAN transmission speed, etc.) required to deliver a full complement of operational products through FOC.

3.2.8.1 Operational Computer Resource Reserves

A distinction is made between the computer resource reserves required for the space segment, for the IDPS, and for the ground elements of the C^3 segment.

TRD3.2.8.1-1
Addition and modification of computer resources in the space elements of later NPOESS flights shall be accommodated by the sensor and spacecraft designs.

TRD3.2.8.1-2
For the IDP segment and for the ground elements of the C^3 segment, the design and installation of the equipment shall be such that equipment modifications may be readily made after the initial installation to meet the growth requirements.

3.2.8.1.1 Computer Resource Reserves for Operational Space Elements

For the purposes of this specification, the data processing subsystems of the operational space elements are defined to comprise all computer hardware and software, in the spacecraft(s), including all interfacing space equipment, all sensors developed or extensively redesigned under NPOESS contracts, and single application, embedded firmware-based processors. This excludes non-NPOESS developed sensors such as SARSAT and ADCS, and other unmodified sensors. Note, however, that the worst case loading, capacity, throughput, and access rate requirements referred to in this specification include the requirements placed upon the data processing subsystems of the space elements by *all* sensors, launch vehicle, spacecraft, and system interfaces. It excludes the stored data recorder and elements of the space to ground data transmission capability.

[Applies only to CrIS and VIIRS for NPP].

TRD3.2.8.1.1-1
The data processors of the space elements shall have 100 percent built in growth margin over the base resource requirement. [Applies only to CrIS and VIIRS for NPP].

TRD3.2.8.1.1-2
The data processors of the space elements shall have, or be capable of having, memory added (through modification, addition, or replacement) to attain a 200 percent greater memory capacity than the base resource requirement. [Applies only to CrIS and VIIRS for NPP].

3.2.8.1.1.1 DELETED

TRD3.2.8.1.1.1-1 DELETED

3.2.8.1.1.2 DELETED

TRD3.2.8.1.1.2-1 DELETED

TRD3.2.8.1.1.2-2 DELETED

3.2.8.1.1.3 DELETED

TRD3.2.8.1.1.3-1 DELETED

TRD3.2.8.1.1.3-2 DELETED

3.2.8.1.1.4 DELETED

TRD3.2.8.1.1.4-1 DELETED

TRD3.2.8.1.1.4-2 DELETED

3.2.8.1.1.5 Data Processing Subsystems Software/Firmware

TRD3.2.8.1.1.5-1
Any hardware augmentations necessary to meet the expansion requirements shall be designed so that the software and firmware in the data processing subsystems of the space elements are upward compatible with the implementation of those augmentations. [Not applicable to NPP.]

3.2.8.1.2 Computer Resource Reserves for Operational Ground Equipment

For the purposes of this specification, the operational data processing subsystems of the ground elements of the NPOESS system are defined to comprise all computer hardware and software required by the IDPS Central element and by the ground elements of the C^3 segment that are required to meet operational product delivery. Reserve requirements to support program expansion in terms of additional use of existing functions are necessary in the ground elements of the operational data processing subsystems of the NPOESS system, and may be used for non-conflicting development and test activities.

This section does not apply to inter-facility communications resources.

TRD3.2.8.1.2-1
The data processing subsystems of the ground elements shall have 100 percent built in growth margin over the base resource requirement. That is, the C3 segment hardware and software must have the capacity to transmit, and the IDPS hardware and software must have the capacity to ingest, process, and store twice the base resource requirement. [Not Applicable to NPP.]

TRD3.2.8.1.2-2
Base and reserve processing throughput, memory, and storage capacity shall be installed prior to the launch readiness date for each NPOESS satellite. [Not Applicable to NPP.]

TRD3.2.8.1.2-3
The data processing subsystems of the ground elements shall have, or be capable of having, memory added (through modification, addition, or replacement) to attain a 200 percent greater memory capacity than the base resource requirement. [Not Applicable to NPP.]

3.2.8.1.2.1 DELETED

TRD3.2.8.1.2.1-1 DELETED

3.2.8.1.2.2 DELETED

TRD3.2.8.1.2.2-1 DELETED

TRD3.2.8.1.2.2-2 DELETED

3.2.8.1.2.3 DELETED

TRD3.2.8.1.2.3-1 DELETED

3.2.8.1.2.4 DELETED

TRD3.2.8.1.2.4-1 DELETED

3.2.8.1.2.5 Data Processing Subsystems Software/Firmware

TRD3.2.8.1.2.5-1
Any hardware augmentations necessary to meet the expansion requirements specified shall be designed so that the software and firmware in each data processing subsystem of the ground elements is upward compatible with the implementation of those augmentations. [Not Applicable to NPP.]

3.2.8.2 Non-operational Computer Resource Reserves

3.2.8.2.1 DELETED

TRD3.2.8.2.1-1 DELETED

3.2.8.2.2 DELETED

TRD3.2.8.2.2-1 DELETED

3.2.8.2.3 Network Structure

TRD3.2.8.2.3-1 DELETED

TRD3.2.8.2.3-2
The capability of the network architecture shall allow for a system growth of 200% in terms of nodes and total amount of data transmitted on the network. [Not Applicable to NPP.]

3.2.9 DELETED

TRD3.2.9-1 DELETED

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials

TRD3.3.1-1
Unless otherwise specified, the parts, materials, and processes shall be selected and controlled in accordance with contractor-documented procedures to satisfy the specified reliability requirements.

3.3.1.1 Toxic Products and Formulations

TRD3.3.1.1-1 DELETED

3.3.1.2 Parts Selection

Care should be exercised in the selection of materials and processes for the space equipment to avoid stress corrosion cracking in highly stressed parts and to preclude failures induced by hydrogen embrittlement.
Parts, materials, and processes should be selected to ensure that any damage or deterioration from storage or the space environment or the outgassing effects in the space environment would not reduce the performance of the space equipment beyond the specified limits.

TRD3.3.1.2-1
Parts for space usage shall be chosen to meet the reliability and operational service life requirements. (Use Preferred Parts List PPL-21, Goddard Space Flight Center, as a guide).

TRD3.3.1.2-2 DELETED

TRD3.3.1.2-3 DELETED

TRD3.3.1.2-4 DELETED

3.3.1.3 Material Selection

Materials for the space equipment will be selected for low outgassing in accordance with SP-R-0 022A (NASA JSC) and resistance to the effects of incident radiation.

TRD3.3.1.3-1 DELETED

TRD3.3.1.3-2
Materials shall be corrosion resistant or shall be suitably treated to resist corrosion when subjected to the specified environments.

TRD3.3.1.3-3 DELETED

TRD3.3.1.3-4 DELETED

TRD3.3.1.3-5 DELETED

TRD3.3.1.3-6 DELETED

3.3.1.4 Protective Coatings and Finishes

TRD3.3.1.4-1
The finishes used shall ensure that the completed devices are resistant to corrosion caused by environmental conditions and galvanic action.

TRD3.3.1.4-2
Neither cadmium, chromium, zinc, nor tin plating shall be used for space equipment.

TRD3.3.1.4-3
Pure tin or tin alloy (>98% Sn) plating shall not be used on electrical devices and hardware. The guiding document for this prohibition is MIL-HDBK-1547A, "Electronic Parts, Materials, and Processes for Space and Launch Vehicles."

3.3.2 Electromagnetic Radiation

TRD3.3.2-1
The satellite shall be electromagnetically compatible with itself, including all GFE transmitters and equipment. [Not applicable to NPP.]

TRD3.3.2-2
Ground systems shall be electromagnetically compatible with their known equipment and any existing equipment residing in the same facility.

TRD3.3.2-3
All support facilities, including test facilities and launch base facilities, shall comply with the ground EMC requirements. [Applies only to CrIS and VIIRS facilities for NPP]

TRD3.3.2-4
The space segment EMC requirements shall be in accordance with MIL-STD-461E and MIL-STD-1541A.

TRD3.3.2-5 DELETED

3.3.3 Not Used

3.3.4 DELETED

TRD3.3.4-1 DELETED

TRD3.3.4-2 DELETED

3.3.5 Interchangeability

TRD3.3.5-1
All ground segments shall be configured for modular replacement of components to expedite maintenance and repair.

TRD3.3.5-2
All components, assemblies, subassemblies, and modules that are identical with respect to fit, form, and function shall be interchangeable.

TRD3.3.5-3
Parts not functionally, electrically and dimensionally interchangeable shall have different part numbers.

3.3.6 Safety Requirements

TRD3.3.6-1
System hazards to personnel, hardware, or the environment during design, test, manufacture, integration and assembly, handling, transportation, and operations of the NPOESS System shall be identified and controlled or eliminated (reference MIL-STD-882D for developed items, best practices for commercial equipment).

TRD3.3.6-2 DELETED

TRD3.3.6-3
Satellites developed for this program shall comply with EWR 127-1 in the areas of design for range safety, flight termination, launch integration, and ground operations. [Not applicable to NPP.]

TRD3.3.6-4
The Systems that control hazardous operations (e.g., propulsion systems, electro-explosive devices, electromechanical release devices, etc.) shall be assessed for hazard severity and probability (ref AFM 91-201 and MIL-STD 882D).

TRD3.3.6-5 DELETED

3.3.7 Human Engineering

All new facilities and equipment designs, and the design of modifications to existing facilities and equipment should be in accordance with the provisions of MIL-STD-1472F. The human computer interface should be in accordance with AIAA R-023A-1995, *Recommended Practice -- Human Computer Interface for Space System Operations.* The operator-hardware and operator-software interfaces will be designed to maximize safety, efficiency, and usability, and minimize number of personnel, resources, skills, and training.

TRD3.3.7-1 DELETED

TRD3.3.7-2 DELETED

3.3.8 Nuclear Control

TRD3.3.8-1 DELETED

3.3.9 System Security

TRD3.3.9-1
System security shall be consistent with the NPOESS Program Protection Plan.

TRD3.3.9-2
The system shall be consistent with the National Information Assurance Policy for US Space Systems (NSTISSP No. 12). [Not Applicable to NPP]

3.3.9.1 COMSEC, TEMPEST, and COMPUSEC

3.3.9.1.1 Communications Security (COMSEC)

Communications security (COMSEC) measures provide protection for the transmission of sensitive information.

TRD3.3.9.1.1-1
The system shall source-authenticate all ground-to-space commands.

TRD3.3.9.1.1-2
The satellite shall not accept invalid commands, noise, or spoofing as valid commands. [Not applicable to NPP.]

TRD3.3.9.1.1-3
Commands that fail authentication shall not be executed. [Not applicable to NPP.]

TRD3.3.9.1.1-4
Commands that fail authentication shall be reported in telemetry. [Not applicable to NPP.]

TRD3.3.9.1.1-5
The system shall be designed such that no single failure will allow disclosure of classified NPOESS information. [Not applicable to NPP.]

TRD3.3.9.1.1-6
The MMC shall have the capability to notify the operators of any commands that are reported in the real time telemetry as having failed authentication.

3.3.9.1.1.1 Encryption

TRD3.3.9.1.1.1-1
The uplink transmission of satellite commands and memory loads shall be encrypted at the source (at DoD “Secret” level) and decrypted at the final destination using modern, chip based National Security Agency (NSA) approved devices. (Ref. NSTISSP No. 12) (The content of the commands and memory loads is not classified.) [Not applicable to NPP.]

TRD3.3.9.1.1.1-2 DELETED

TRD3.3.9.1.1.1-3
When data denial is required, all data, except SARSAT and ADCS, shall be encrypted at the satellite and decrypted at the final destination (internal to NPOESS) using commercially available AES. [Not applicable to NPP.]

TRD3.3.9.1.1.1-4 DELETED

TRD3.3.9.1.1.1-5 DELETED

TRD3.3.9.1.1.1-6
The system shall support individual receiver key enabling, i.e. compromised or unauthorized keys can be "purged". [Not applicable to NPP.]

TRD3.3.9.1.1.1-7
The system shall be capable of being re-keyed over the air and supported by a key escrow/control system. [Not applicable to NPP.]

TRD3.3.9.1.1.1-8 DELETED

TRD3.3.9.1.1.1-9
Satellite commands and memory loads shall always be encrypted at the source (i.e. MMC) and decrypted at the final destination (i.e. NPP satellite) using (TBS) encryption devices. [NPP only]

TRD3.3.9.1.1.1-10
Real-time and stored telemetry shall always be encrypted at the satellite and decrypted at the final internal NPOESS destination using AES with an unclassified key. [Not applicable to NPP.]

TRD3.3.9.1.1.1-11
SMD, HRD, and LRD links shall broadcast unencrypted (in the clear), unless in Selective Data Encryption Mode. [Not applicable to NPP.]

TRD3.3.9.1.1.1-12
When in the Selective Data Encryption Mode, SMD, HRD, and LRD links shall be encrypted at the satellite and decrypted at the final internal NPOESS destination using AES with an unclassified key that is different than the telemetry key in TRD3.3.9.1.1.1-10. [Not applicable to NPP.]

3.3.9.1.2 Compromising Emanations (TEMPEST)

NPOESS TEMPEST requirements should be based on site-specific RED/BLACK guidance per NSTISSAM TEMPEST/2-95. The TEMPEST program should follow processes of NSTISSI 7000 and verification of critical equipment should be per NACSEM 5112 HIJACK and NONSTOP requirements. [Not applicable to NPP.]

3.3.9.1.3 Computer Security (COMPUSEC)

Any NPOESS element that processes multiple security levels of data should comply with DOD 5200.28-STD, paragraph 3.1.1.3.

TRD3.3.9.1.3-1
NPOESS data shall reside in and operate under an environment that meets the class C2 criteria as defined by DOD 5200.28-STD paragraph 2.2, while within NPOESS segments.

TRD3.3.9.1.3-2
NPOESS shall provide the capability to verify the integrity and source of all information transferred between elements.

TRD3.3.9.1.3-3
NPOESS shall provide the capability to restrict subjects' (e.g., operators') privileges to access only those objects (e.g., data and programs) necessary to perform their tasks.

3.3.10 DELETED

3.3.11 Computer Resources

Computer resources include all computer software and the associated computational equipment included within the System.

TRD3.3.11-1 DELETED

3.3.11.1 Operational Computer Resources

3.3.11.1.1 Operational Computational Equipment

The computational equipment includes processing units; special-purpose computational devices; main storage; peripheral data storage; input and output units such as printers, graphic displays, video display devices; networks, network interfaces, routers, and bridges; and other associated devices. It also includes off-line development systems which are used to develop operational code.

3.3.11.1.2 Operating Systems Used in Operational Computers

TRD3.3.11.1.2-1
The operational computers shall be able to exchange information with their host facility systems.

TRD3.3.11.1.2-2 DELETED

TRD3.3.11.1.2-3 DELETED

TRD3.3.11.1.2-4 DELETED

3.3.11.1.3 DELETED

3.3.11.1.3.1 DELETED

TRD3.3.11.1.3.1-1 DELETED

TRD3.3.11.1.3.1-2 DELETED

3.3.11.1.3.2 Message Generation

TRD3.3.11.1.3.2-1
The ground operational computer software shall generate error messages, diagnostic messages, and alarm messages on-line to facilitate real-time fault isolation required to maintain the System in operational status.

TRD3.3.11.1.3.2-2
In addition, the ground operational computer software shall generate off-line error and diagnostic messages for the logging of fault messages onto system files for those categories of faults that require isolation and correction but can be addressed off-line and do not degrade System performance.

3.3.11.1.3.3 Computer Resource Utilization Monitoring

TRD3.3.11.1.3.3-1
All ground operational computer resources shall provide a capability which can be exercised under operator control to monitor, record, display, and print the utilization of the various computer resources.

TRD3.3.11.1.3.3-2
All space operational computer resources shall provide a capability which can be exercised under operator control to monitor and record the utilization of the various computer resources. [Not applicable to NPP.]

3.3.11.1.4 DELETED

TRD3.3.11.1.4-1 DELETED

3.3.11.1.5 DELETED

TRD3.3.11.1.5-1 DELETED

TRD3.3.11.1.5-2 DELETED

3.3.11.1.6 DELETED

TRD3.3.11.1.6-1 DELETED

TRD3.3.11.1.6-2 DELETED

3.3.11.2 Software Design Interoperability, and Support

NPOESS should maximize compatibility with existing systems. To the greatest extent possible, NPOESS software that is operational at multiple sites should be identical (e.g., IDPS software should be identical at every IDPS location; software should be identical at the primary and backup MMC sites). Differences between sites related to environment, configuration, operations, etc. should be handled through the use of site-specific data files and configurable parameters. The NPOESS should comply with appropriate Government and commercial information technology standards of the latest date as of contract award.

TRD3.3.11.2-1
The IDPS and FTS shall be compliant with the Department of Defense (DoD) Joint Technical Architecture (JTA) and Defense Information Infrastructure-Common Operating Environment (DII-COE); C3, Launch, and Space segments are excluded from the requirement to be DII-COE compliant.

TRD3.3.11.2-2
All NPOESS software (i.e., operational and support) shall be developed and maintained in accordance with the Government-approved Software Development Plan (SDP). (NOTE: COTS software management is discussed within the SDP.)

TRD3.3.11.2-3
Software which uses mission time shall be consistent with the US Naval Observatory definition of Coordinated Universal Time [UTC(USNO)], including the leap-second convention.

TRD3.3.11.2-4
All NPOESS interfaces (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance – C4ISR) shall comply with the JTA specifications and standards.

3.3.11.2.1 Programming Languages and Coding Conventions

TRD3.3.11.2.1-1
System and application software developed for NPOESS shall be implemented in widely used programming languages governed by published government and/or ISO, ANSI, or IEEE standards.

TRD3.3.11.2.1-2
In the event that it is advantageous to NPOESS to use a programming language that is not governed by a published standard, or to use non-standard language extensions, the contractor shall use the programming language only with an approved Government waiver.

TRD3.3.11.2.1-3
Code shall be written such that no code is modified during execution.

3.3.11.3 Computer Resources in Training Equipment

TRD3.3.11.3-1
To the extent practicable, the computational training equipment that provides operator displays and controls shall be identical to the corresponding operational computational equipment.

3.3.12 Satellite Design Requirements

3.3.12.1 General Structural Design

[Not applicable to NPP.]

The primary support structure for the space equipment should possess sufficient strength, rigidity, and other characteristics required to survive the critical loading conditions that exist within the envelope of handling and mission requirements.

3.3.12.2 Strength Requirements

[Not applicable to NPP.]

3.3.12.2.1 Yield Load

TRD3.3.12.2.1-1
The structure shall be designed to have sufficient strength to withstand simultaneously the yield loads, applied temperature, and other accompanying environmental phenomena for each design condition without experiencing yielding or detrimental deformation. [Not applicable to NPP.]

3.3.12.2.2 Ultimate Load

TRD3.3.12.2.2-1
The structure shall be designed to withstand simultaneously the ultimate loads, applied temperature, and other accompanying environmental phenomena without failure. [Not applicable to NPP.]

3.3.12.3 Stiffness Requirements

3.3.12.3.1 Dynamic Properties

TRD3.3.12.3.1-1
The structural dynamic properties of the equipment shall be such that its interaction with the spacecraft control subsystem does not result in unacceptable degradation of performance. [Not applicable to NPP.]

TRD3.3.12.3.1-2 DELETED

3.3.12.3.2 Structural Stiffness

TRD3.3.12.3.2-1
Stiffness of the structure and its attachments shall be controlled by the equipment performance requirements and by consideration of the handling and launch environments.

TRD3.3.12.3.2-2 DELETED

3.3.12.3.3 Component Stiffness

TRD3.3.12.3.3-1
The fundamental resonant frequency of a component weighing 23 kilograms or less shall normally be 50 Hertz or greater when mounted on its immediate support structure.

TRD3.3.12.3.3-2
Detailed analyses of the potential responses of the component to inputs from the adjoining structure(s) shall be required for components weighing 23 kilograms or less and having fundamental resonant frequencies of less than 50 Hertz.

3.3.12.4 Structural Factors of Safety

The factor of safety of the structure is the ratio of the limit load to the allowable load.

3.3.12.4.1 Flight Limit Loads

TRD3.3.12.4.1-1
The structure shall comply with the contractor's minimum required structural design factors of safety (TBD).

3.3.12.4.2 Pressure Loads

[Not applicable to NPP.]

TRD3.3.12.4.2-1
Factors of safety for pressure loads shall be determined individually for each pressure vessel, based on tests to establish material characteristics and an analysis of life requirements and other environmental exposure. [Not applicable to NPP.]

TRD3.3.12.4.2-2
Proof and burst pressure factors shall be established at levels that ensure structural integrity, structural life, and safety throughout all phases. [Not applicable to NPP.]

3.3.12.5 Design Load Conditions

TRD3.3.12.5-1
The satellite equipment shall be capable of withstanding all design load conditions to which it is exposed in all mission phases, as applicable: ground, prelaunch, erection, post-launch, boost and orbit.

TRD3.3.12.5-2
During the orbit phase, the NPOESS satellite shall withstand the following: maneuvering loads, vehicle spin, meteoroid environment, radiation environment, and other environmental factors, such as thermal effects due to internal heating, solar heating, eclipses, and extreme cold due to ambient space environment. For NPP, the above applies only to VIIRS and CrIS.

3.3.12.6 Spacecraft Fluid Subsystems

[Not applicable to NPP.]

3.3.12.6.1 Pressurized Components

Fluid subsystem and pressurized components should be in accordance with MIL-STD-1522A. [Not applicable to NPP.]

TRD3.3.12.6.1-1 DELETED

3.3.12.6.2 DELETED

TRD3.3.12.6.2-1 DELETED

3.3.12.6.3 DELETED

TRD3.3.12.6.3-1 DELETED

TRD3.3.12.6.3-2 DELETED

TRD3.3.12.6.3-3 DELETED

TRD3.3.12.6.3-4 DELETED

TRD3.3.12.6.3-5 DELETED

3.3.12.7 Moving Mechanical Assemblies

TRD3.3.12.7-1
Deployment mechanisms, sensor mechanisms, pointing mechanisms, drive mechanisms, de-spin mechanisms, separation mechanisms, and other moving mechanical assemblies on the spacecraft shall be in accordance with best commercial practices.

3.3.12.8 Explosive Ordnance

Explosive ordnance to be installed on a spacecraft should be in accordance with MIL-HDBK-83578.

TRD3.3.12.8-1 DELETED

TRD3.3.12.8-2 DELETED

3.3.12.9 DELETED

3.3.12.10 DELETED

3.3.12.11 DELETED

3.3.13 Operational Ground Equipment: General Design Requirements

These requirements only apply to specialized mechanical assemblies, other than COTS equipment, which have received Underwriters Laboratory or (TBD) approval.

3.3.13.1 General Structural Design

TRD3.3.13.1-1
The primary support structure for the ground equipment shall possess sufficient strength, rigidity, and other characteristics required to survive the critical loading conditions that exist within the envelope of handling and mission requirements.

TRD3.3.13.1-2 DELETED

TRD3.3.13.1-3 DELETED

TRD3.3.13.1-4
Federal, State, local, and host facility safety regulations shall be met.

3.3.13.2 DELETED

3.3.13.2.1 DELETED

TRD3.3.13.2.1-1 DELETED

3.3.13.2.2 DELETED

TRD3.3.13.2.2-1 DELETED

3.3.13.3 DELETED

3.3.13.3.1 DELETED

TRD3.3.13.3.1-1 DELETED

3.3.13.3.2 DELETED

TRD3.3.13.3.2-1 DELETED

TRD3.3.13.3.2-2 DELETED

3.3.13.4 DELETED

3.3.13.4.1 DELETED

TRD3.3.13.4.1-1 DELETED

3.3.13.4.2 DELETED

TRD3.3.13.4.2-1 DELETED

TRD3.3.13.4.2-2 DELETED

TRD3.3.13.4.2-3 DELETED

TRD3.3.13.4.2-4 DELETED

3.3.13.5 DELETED

TRD3.3.13.5-1 DELETED

3.3.13.5.1 DELETED

TRD3.3.13.5.1-1 DELETED

3.3.13.5.2 DELETED

TRD3.3.13.5.2-1 DELETED

3.3.13.6 DELETED

3.3.13.6.1 DELETED

3.3.13.6.2 DELETED

TRD3.3.13.6.2-1 DELETED

TRD3.3.13.6.2-2 DELETED

TRD3.3.13.6.2-3 DELETED

3.3.13.6.3 DELETED

TRD3.3.13.6.3-1 DELETED

3.3.14 Test Equipment

Test equipment is that equipment required to support the maintenance, repair, and checkout of the System following System deployment.

TRD3.3.14-1
To the extent practicable, test equipment shall be designed using applicable commercial practices.

TRD3.3.14. -2
Commercially available modules shall be used to the extent practicable.

3.3.15 General Construction Requirements

3.3.15.1 Processes and Controls for Space Equipment

Acceptance and flight certification of space equipment is based primarily on an evaluation of data from the manufacturing process.

TRD3.3.15.1-1
The manufacturing process for space equipment shall be accomplished in accordance with documented procedures and process controls which assure the reliability and quality required for the mission.

TRD3.3.15.1-2
These manufacturing procedures and process controls shall be documented to give visibility to the procedures and specifications by which all processes, operations, inspections, and tests are to be accomplished by the supplier.

TRD3.3.15.1-3
This internal contractor documentation shall include the name of each part or component, each material required, the point at which each enters the manufacturing flow, and the controlling specification or drawing.

TRD3.3.15.1-4
The documentation shall indicate required tooling, facilities, and test equipment; the manufacturing checkpoints; the quality assurance verification points; and the verification procedures corresponding to each applicable process or material listed.

TRD3.3.15.1-5
The specifications, procedures, drawings, and supporting documentation shall reflect the specific revisions in effect at the time the items were produced.

TRD3.3.15.1-6
These flow charts and the referenced specifications, procedures, drawings, and supporting documentation become the manufacturing process control baseline and shall be retained by the supplier for reference.

TRD3.3.15.1-7
It is recognized that many factors may warrant making changes to this documented baseline; however, all changes to the baseline processes used, or the baseline documents used, shall be recorded by the supplier following establishment of the manufacturing baseline. These changes provide the basis for flight accreditation of the items manufactured or of subsequent flight items.

TRD3.3.15.1-8
The manufacturing process and control documents for space equipment shall provide a supplier-controlled baseline that assures that any subsequent failure or discrepancy analysis that may be required can identify the specific manufacturing materials and processes that were used for each item. In that way, changes can be incorporated to a known baseline to correct the problems.

3.3.15.1.1 Assembly Lots

TRD3.3.15.1.1-1
To the extent practicable, parts for use in space equipment shall be grouped together in individual assembly lots during the various stages of their manufacture to assure that all devices assembled during the same time period use the same materials, tools, methods, and controls.

TRD3.3.15.1.1-2
Parts and devices for space equipment that cannot be tested adequately after assembly without destruction of the item, such as explosive ordnance devices, some propulsion components, and complex electronics, shall have lot controls implemented during their manufacture to assure a uniform quality and reliability level of the entire lot.

TRD3.3.15.1.1-3
Each lot shall be manufactured, tested, and stored with sequential lot numbers that indicate the date of manufacture assigned to each lot. (Typically, use three digits for the day of the year and four digits for the year.)

3.3.15.1.2 Contamination

The spacecraft and sensor designs are to consider deployment systems and outgassing materials selection that minimize particle release or completely eliminate the escape of actuating materials. As part of the contamination control analysis and ICD development, the integrating contractor is to perform a particulate and molecular plume flowfield analysis for all spacecraft thrusters, and a contamination analysis for all sensitive devices and surfaces. [Not applicable to NPP.]

3.3.15.1.2.1 Fabrication and Handling

TRD3.3.15.1.2.1-1
Fabrication and handling of space equipment shall be accomplished in a clean environment.

TRD3.3.15.1.2.1-2
Attention shall be given to avoiding non-particulate (chemical) as well as particulate air contamination.

TRD3.3.15.1.2.1-3
To avoid safety and contamination problems, the use of liquids shall be minimized in areas where initiators, explosive bolts, or any loaded explosive devices are exposed.

3.3.15.1.2.2 Device Cleanliness

The particulate cleanliness of internal moving subassemblies should be maintained to at least level 500 as defined in MIL-STD-1246C.

TRD3.3.15.1.2.2-1 DELETED

3.3.15.1.2.3 Outgassing

TRD3.3.15.1.2.3-1
Items that might otherwise produce deleterious outgassing while on orbit shall be baked for a sufficient time to drive out all but an acceptable level of outgassing products prior to installation in the experiment or satellite.

TRD3.3.15.1.2.3-2
Analytical contamination models shall be used to evaluate performance impacts of outgassing on adjacent critical equipment [Not applicable to NPP.]

3.3.15.1.3 Electrostatic Discharge

TRD3.3.15.1.3-1
Appropriate provisions shall be used to avoid and to protect against the effects of static electricity generation and discharge in areas containing electrostatic sensitive devices such as microcircuits, initiators, explosive bolts, or any loaded explosive device. MIL-HDBK-263B provides examples of appropriate provisions.

TRD3.3.15.1.3-2
There shall be a capability to ground both equipment and personnel working on and around the satellite, subsystems, and components. All support facilities, including test facilities and launch base facilities, should comply with the grounding requirements of MIL-STD-1542B and NOAA S24.809.

3.3.15.1.4 DELETED

TRD3.3.15.1.4-1 DELETED

3.3.15.2 DELETED

TRD3.3.15.2-1 DELETED

3.4 DOCUMENTATION

3.4.1 DELETED

TRD3.4.1-1 DELETED

3.4.1.1 DELETED

TRD3.4.1.1-1 DELETED

3.4.2 Interface Control Documents

Interface Control Documents (ICDs) will be used to define and control the interfaces within the NPOESS System and between the NPOESS System and external users.

TRD3.4.2-1 DELETED

TRD3.4.2-2 DELETED

TRD3.4.2-3 DELETED

TRD3.4.2-3 DELETED

TRD3.4.2-4 DELETED

TRD3.4.2-5 DELETED

TRD3.4.2-6 DELETED

TRD3.4.2-7 DELETED

TRD3.4.2-8 DELETED

TRD3.4.2-9 DELETED

TRD3.4.2-10 DELETED

TRD3.4.2-11 DELETED

TRD3.4.2-12 DELETED

TRD3.4.2-13 DELETED

TRD3.4.2-14 DELETED

TRD3.4.2-15 DELETED

3.4.3 DELETED

TRD3.4.3-1 DELETED

3.4.4 DELETED

TRD3.4.4-1 DELETED

3.4.5 DELETED

DELETED

TRD3.4.5-1 DELETED

TRD3.4.5-2 DELETED

3.5 LOGISTICS

Integrated Logistics Support (ILS) should minimize the impact of NPOESS on the existing support infrastructure while ensuring the lowest NPOESS life cycle cost and while providing full and timely logistics response. This goal should be accomplished by the application of sound supportability decisions regarding mission equipment design, support systems development, and support products acquisition.

TRD3.5-1
Supportability criteria shall be imposed on equipment selection and System designs to minimize the System life cycle costs.

3.5.1 Maintenance Planning

TRD3.5.1-1
Maintenance plans and procedures shall be consistent with the overall system and segment availability criteria.

TRD3.5.1-2 DELETED.

TRD3.5.1-3 DELETED.

TRD3.5.1-4
The maintenance concept shall cover all non-GFE equipment, parts, labor, and software (including COTS).

3.5.1.1 Space Segment Maintenance Concepts (TBD)

3.5.1.2 C3S and IDPS Maintenance Concepts

DELETED.

TRD3.5.1.2-1 DELETED

TRD3.5.1.2-2 DELETED

TRD3.5.1.2-3 DELETED

TRD3.5.1.2-4 DELETED

TRD3.5.1.2-5
The C3S and IPDS shall be configured to allow hardware and software components to be repaired or replaced without the loss of data or satellite mission to a level meeting specified NPOESS data availability requirements. Approved procedures will predetermine repair or replacement of hardware.

TRD3.5.1.2-6
A maintenance capability shall be provided for the NPOESS unique C3S and IDPS equipment (including equipment at the MMCs, at the command data acquisition stations, and at Centrals) that is consistent with the overall system and segment availability criteria.

TRD3.5.1.2-7 DELETED

TRD3.5.1.2-8
Sufficient redundancy shall exist that hardware and software maintenance and upgrades can be performed and tested on portions of the system without affecting the ongoing operations.

3.5.1.3 IDP Field Terminal Maintenance Concept

Field level maintenance and installation of the software for the field terminals will be performed by DoD/DOC personnel following appropriate IDPS software maintenance training. Maintenance will be consistent with the field terminal operations and maintenance concepts.

TRD3.5.1.3-1 DELETED

TRD3.5.1.3-2 DELETED

TRD3.5.1.3-3 DELETED

3.5.1.3.1 DELETED

TRD3.5.1.3.1-1 DELETED

TRD3.5.1.3.1-2 DELETED

TRD3.5.1.3.1-3 DELETED

TRD3.5.1.3.1-4 DELETED

TRD3.5.1.3.1-5 DELETED

TRD3.5.1.3.1-6 DELETED

3.5.1.3.2 DELETED

TRD3.5.1.3.2-1 DELETED

3.5.2 Provisioning Strategy/Spares Concept

The NPOESS system requires spare parts to ensure overall NPOESS system reliability and availability.

TRD3.5.2-1 DELETED

3.5.3 Support Equipment

The need for unique support equipment should be minimized by the careful selection of COTS hardware and software.

3.5.4 Packaging, Handling, Storage, and Transportation (PHS&T)

TRD3.5.4-1 DELETED

3.5.5 Facilities

Existing government facilities may be available for operations, maintenance, or storage of NPOESS system components.

3.6 PERSONNEL AND TRAINING

TRD3.6-1 DELETED

TRD3.6-2 DELETED

TRD3.6-3 DELETED

TRD3.6-4 DELETED

TRD3.6-5 DELETED

TRD3.6-6 DELETED

3.6.1 DELETED

TRD3.6.1-1 DELETED

3.6.2 DELETED

TRD3.6.2-1 DELETED

TRD3.6.2-2 DELETED

3.7 SEGMENT CHARACTERISTICS

This section states the requirements that have been allocated to the segments. However, to avoid duplication, requirements that normally would appear in both 3.2 and 3.7 are only stated in this section.

3.7.1 Space Segment (SS)

The space segment consists of a constellation of satellites and space segment related ground support equipment.

TRD3.7.1-1
The space segment shall be capable of supporting an individual satellite in each of the satellite modes (defined in 3.7.1.2.1 Satellite Modes). [Not applicable to NPP.]

TRD3.7.1-2
The spacecraft to sensor interfaces shall comply with the NPOESS General Instrument Interface Document (GIID).

TRD3.7.1-3
The space segment shall time stamp all CCSDS packet headers with the UTC time of the event (e.g. start of scan) measured.

3.7.1.1 Constellation Requirements

NPOESS satellites should be equally spaced to the maximum extent possible and should provide adequate coverage of the dawn/dusk transitions and the approximate noon/midnight fluctuations of the ionosphere and magnetosphere. [Not applicable to NPP.]

TRD3.7.1.1-1
NPOESS satellites shall be flown at a nominal nodal crossing time of 1730 Local Mean Solar Time (LMST) (ascending), 1330 LMST (ascending), and 2130 LMST (ascending) to optimize satisfaction of DoD and DOC requirements. [Not applicable to NPP.]

TRD3.7.1.1-2
All satellites in the NPOESS constellation shall be sun-synchronous such that each satellite images/measures the same latitude at the same local mean solar time (LMST) each day, within +/- 10 minutes.

TRD3.7.1.1-3
The NPOESS satellite shall be capable of flying at any equatorial nodal crossing time, except 12:00 +/-20 minutes. [Not applicable to NPP.]

TRD3.7.1.1-4
The orbit altitude for all satellites in the NPOESS constellation shall be 833 ± 17 km. [Not applicable to NPP.]

TRD3.7.1.1-5
The orbit inclination for all satellites in the NPOESS constellation shall be 98.7 ± 0.05 degrees. [Not applicable to NPP.]

TRD3.7.1.1-6
The NPOESS system shall be capable of maintaining an orbit where the sunlight is kept off the cold side of the satellite[s]. [Not applicable to NPP.]

TRD3.7.1.1-7
The US NPOESS space segment shall provide [1] all data required from the 1730 and 1330 orbits and [2] all data required from the 2130 orbit that are not available from the METOP satellite or any other space-based source. [Not applicable to NPP.]

TRD3.7.1.1-8
The orbital parameters for the NPP satellite shall be: a) orbit altitude = 824 (TBR) ± (TBR) km; b) ground track repeatability = ± 20 km, all latitudes, cross track; c) nodal crossing time = descending node of 10:30 a.m. ± 10 minutes; and d)repeat cycle = 16 days (TBR), while in normal operational mode throughout the mission lifetime. [NPP ONLY – NPP satellite design and launch is the responsibility of NASA and the NPP contractor.]

3.7.1.2 Satellite Requirements

TRD3.7.1.2-1 DELETED

TRD3.7.1.2-2 DELETED

TRD3.7.1.2-3 DELETED

TRD3.7.1.2-4 DELETED

TRD3.7.1.2-5
The NPOESS satellites shall be designed in accordance with the 1997 NASA/DoD developed US Government Orbital Debris Minimization Standard Practices, which is based on the National Space Policy for minimization of space debris. If there is a derived requirement to have a controlled deorbit for an NPOESS satellite, the reliability of the deorbit control function should be consistent with the overall derived NPOESS mission reliability requirements. [Not applicable to NPP.]

TRD3.7.1.2-6
The satellites shall operate within specifications in the natural environments of their operational orbits.

TRD3.7.1.2-7
The satellite shall be able to separately command any sensor suite into any sensor mode.

TRD3.7.1.2-8
GPS or equivalent shall be used to meet positioning requirements derived from Appendix D EDR requirements.

TRD3.7.1.2-9
The system shall perform primary satellite navigation and timing with a GPS receiver system that is Selective Availability Anti-Spoofing Module (SAASM) compliant. (Ref. NAVSTAR GPS SAASM System Specification, SS-GPS-001 and 2000 CJCS Master Positioning, Navigation, and Timing Plan) [Not applicable to NPP]

TRD3.7.1.2-10
NPOESS satellite location and attitude information shall be provided with environmental data to accurately locate the data source.

3.7.1.2.1 Satellite Modes

3.7.1.2.1.1 Off Mode

TRD3.7.1.2.1.1-1
In the Off Mode, no power shall be supplied to the satellite.

3.7.1.2.1.2 Operational Mode

TRD3.7.1.2.1.2-1
The satellite shall have at least one Operational Mode for collecting data as defined in the applicable sensor-spacecraft ICDs.

TRD3.7.1.2.1.2-2 DELETED

3.7.1.2.1.3 Safe Hold Mode

In the case of an anomalous satellite event, it may be necessary to enter the Safe Hold Mode to protect the satellite.

TRD3.7.1.2.1.3-1
The satellite shall be capable of being reconfigured, either autonomously or by command, into the Safe Hold mode to protect itself.
[Not applicable to NPP.]

TRD3.7.1.2.1.3-2
The system shall require ground intervention to enter the Operational Mode from the Safe Hold Mode.

TRD3.7.1.2.1.3-3
An NPOESS satellite shall commence safe operations when an anomalous condition, that threatens the health and safety of the satellite, occurs from which the satellite is not able to automatically recover in time to protect itself.

TRD3.7.1.2.1.3-4
During safe operations, the satellite shall sustain the capability to receive the command uplink from the C3 Segment and to transmit real-time telemetry to the C3 Segment.

3.7.1.2.1.4 DELETED

TRD3.7.1.2.1.4-1 DELETED

3.7.1.2.1.5 Diagnostic and Software Maintenance Mode

TRD3.7.1.2.1.5-1
Diagnostic Mode shall include housekeeping, troubleshooting, testing, and software updates. Diagnostic data should be included with the SMD. It is not required in the HRD.

TRD3.7.1.2.1.5-2
The satellite, including all newly developed sensors, shall be reprogrammable on-orbit to allow for new versions of software and table values to be loaded from the ground. [Not applicable to NPP]

TRD3.7.1.2.1.5-3
Software uploads shall be accomplished without interrupting other satellite operations.

3.7.1.2.2 DELETED

TRD3.7.1.2.2-1 DELETED

3.7.1.3 Space Segment Ground Support Equipment

TRD3.7.1.3-1 DELETED

3.7.1.4 Sensor Suites

All passive microwave sensor bands used on NPOESS should be in either the dedicated, or the shared, ITU tables for passive sensor use in accordance with the "Manual of Regulations and Procedures for Federal Radio Frequency Management" September 1995 Edition.

TRD3.7.1.4-1
For each sensor generating data in multiple discrete channels, i.e., spectral bandpasses, microwave frequency ranges, etc., the satellite shall be capable of eliminating one or more channels from its output data stream by command. This capability allows exclusion of data that is degraded or contaminated, or not desired or needed for other reasons. [Not applicable to NPP]

TRD3.7.1.4-2
NPOESS instrument engineering data shall be delivered with the data streams so that changes in responsivity, noise, and other parameters requiring ground processing corrections can be characterized.

3.7.1.4.1 Visible/Infrared Imager Radiometer Suite (VIIRS)

TRD3.7.1.4.1-1
The Visible/Infrared Imager Radiometer Suite (VIIRS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the VIIRS being designed under government contract is described in the "Sensor Specification for the Visible/Infrared Imager Radiometer Suite (VIIRS)".

3.7.1.4.2 Cross-Track Infrared Microwave Sounding Suite (CrIMSS)

3.7.1.4.2.1 Cross-Track Infrared Sounder (CrIS)

TRD3.7.1.4.2.1-1
The Cross-Track Infrared Sounder (CrIS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the CrIS being designed under a government contract is described in the "CrIS Sensor Specification".

3.7.1.4.2.2 Advanced Technology Microwave Sounding Suite (ATMS)

The ATMS is the NPOESS implementation of the Cross-Track Microwave Sensor Sounding Suite (CrMSSS)

TRD3.7.1.4.2.2-1
The Advanced Technology Microwave Sounding Suite (ATMS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the ATMS (being designed under a NASA contract) is described in the "Advanced Technology Microwave Sounder (ATMS) Performance and Operation Specification."

TRD3.7.1.4.2.2-2 DELETED

3.7.1.4.3 Conical Microwave Imager Sounder (CMIS)

TRD3.7.1.4.3-1
The Conical Microwave Imager Sounder (CMIS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the CMIS being designed under a government contract is described in the "NPOESS CMIS SRD". [Not applicable to NPP.]

3.7.1.4.4 Space Environmental Sensor Suite (SESS)

The Space Environmental Sensor Suite (SESS) consists of sets of sensors that provide data on electron density profiles, neutral density, geomagnetic field, precipitating electrons and ions, electric field/ion drift velocity, radiation dose, neutral atmosphere, galactic cosmic rays, trapped particles, ionospheric scintillation, auroral emissions, in-situ plasma measurements and other selected space environmental parameters.

TRD3.7.1.4.4-1
The Space Environmental Sensor Suite (SESS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. [Not applicable to NPP.]

3.7.1.4.5 GPS Occultation Suite (GPSOS)

TRD3.7.1.4.5-1
The GPS Occultation Suite (GPSOS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the GPSOS being designed under a government contract is described in the "NPOESS GPSOS SRD". [Not applicable to NPP.]

3.7.1.4.6 Ozone Mapping and Profiler Suite (OMPS)

TRD3.7.1.4.6-1
The Ozone Mapping and Profiler Suite (OMPS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. The performance of the OMPS being designed under a government contract is described in the "NPOESS OMPS Sensor Specification". [Not applicable to NPP.]

3.7.1.4.7 DELETED

TRD3.7.1.4.7-1 DELETED

TRD3.7.1.4.7-2 DELETED

TRD3.7.1.4.7-3 DELETED

TRD3.7.1.4.7-4 DELETED

3.7.1.4.8 DELETED

TRD3.7.1.4.8-1 DELETED

TRD3.7.1.4.8-2 DELETED

TRD3.7.1.4.8-3 DELETED

TRD3.7.1.4.8-4 DELETED

3.7.1.4.9 Earth Radiation Budget Suite

TRD3.7.1.4.9-1
The Earth Radiation Budget Suite shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. [Not applicable to NPP.]

3.7.1.4.10 Radar Altimeter

TRD3.7.1.4.10-1
The Radar Altimeter shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. [Not applicable to NPP.]

3.7.1.4.11 Total Solar Irradiance Sensor (TSIS)

TRD3.7.1.4.11-1
The Total Solar Irradiance Sensor (TSIS) shall augment the other sensors' capabilities as necessary to meet the EDR requirements in Appendix D. [Not applicable to NPP.]

3.7.1.4.12 P3I Payloads

TRD3.7.1.4.12-1
The spacecraft shall provide additional capacity to accommodate new instruments with a mass equal to 25% (TBR) of the total 1330 payload mass as defined at CDR with no margin. [Not applicable to NPP.]

TRD3.7.1.4.12-2
The spacecraft shall provide additional capacity to accommodate new instruments with power equal to 25% (TBR) of the total 1330 payload power as defined at CDR with no margin. [Not applicable to NPP.]

TRD3.7.1.4.12-3
The spacecraft shall provide additional capacity to accommodate new instruments with a data rate equal to 25% (TBR) of the total 1330 payload data rate as defined at CDR with no margin. [Not applicable to NPP.]

3.7.2 Command, Control, and Communications Segment

NPOESS should have standardized communications protocols to the maximum extent possible to ensure interoperability between the military Services, DoD and civil communities, and allied systems. CDA operations should be automated to improve overall efficiency, reduce the number of on-site support staff required, and reduce costs associated with CDA sites located in hostile and remote locations. MMC personnel should be able to

accomplish SMD data recovery and operate CDA sites in normal/routine situations. On-site CDA staff should be required to intervene only in anomalous situations. In the event of conflict, NPOESS operations have priority over NPP operations.

TRD3.7.2-1
The C3S shall provide all functions required for day-to-day state of health monitoring and commanding of all operating satellites and to support the delivery of data to the Centrals.

TRD3.7.2-2
The C3S shall operate reliably in the specific natural environment for which it is intended. The local climate should be considered in the design, operation, and maintenance of the C3S.

TRD3.7.2-3 DELETED

TRD3.7.2-4 DELETED

TRD3.7.2-5
The C3S shall be capable of providing contact to each satellite at least once per orbit.

TRD3.7.2-6
During NPOESS System Upgrade Mode, the C3S shall maintain the ability to download NPP's SMD at least every other orbit.

3.7.2.1 Mission Management Center

The MMC will provide general mission planning for the operations of the NPOESS including special calibration activities. The MMC will receive mission planning information from the user, scientists, sensor contractors, and others via email and telephone communications. The primary MMC and the backup MMC should be compatible with existing military standards and civil protocols to ensure seamless transition during backup operations, continuity of data flow and processing, and ease of maintenance. A backup MMC is not required for NPP operations. There is no requirement for the NPOESS architecture to perform any functions currently performed by NOAA, or other organizations, for POES, DMSP, or METOP.

3.7.2.1.1 Mission Management

TRD3.7.2.1.1-1
The Mission Management Center shall be capable of performing the following operational functions:

a) satellite command and control,
b) mission planning,
c) resource scheduling,
d) satellite state-of-health trending,
e) monitor, report, and trend on-orbit and ground system configuration management and status,
f) launch and early orbit operations,
g) anomaly resolution,
h) data access,
i) the delivery of data to the IDPSs for the entire NPOESS constellation,
j) orbital analysis and maneuver planning, and
k) management and configuration control of NPP flight software after successful completion of on-orbit checkout and turnover to the contractor [NPP only].

The resource scheduler should be able to: a) schedule routine ground site and MMC satellite operations; b) de-conflict multiple satellite downlink and command uplink requirements; c) identify and resolve specific site convergence of multiple, simultaneous satellite pass support and propose/implement data recovery at one of the other ground sites; d) schedule and maximize the utilization of multiple communication resources; e) be flexible enough to add other satellite support tasks, and f) generate an executable automated schedule.

TRD3.7.2.1.1-2
Routine ground site operations shall be remotely controlled from the Mission Management Center (MMC).

TRD3.7.2.1.1-3
The backup MMC shall be capable of performing the same operational functions as the primary MMC, with the exception of launch and early orbit operations; these will not be done from the backup MMC. [Not applicable to NPP.]

TRD3.7.2.1.1-4
The hardware and software located at the primary and backup MMCs shall be functionally identical and operated and maintained using the same commands and procedures. [Not applicable to NPP.]

TRD3.7.2.1.1-5
The scheduling function shall be designed to enable adjustments to scheduled satellite usage.

TRD3.7.2.1.1-6 DELETED

TRD3.7.2.1.1-7
The MMC shall maintain the on-orbit configuration status of satellite hardware, software, and databases.

TRD3.7.2.1.1-8
The MMC shall have access to spacecraft and sensor flight software, satellite tables, and sensor calibration tables.

TRD3.7.2.1.1-9
The MMC shall verify the correctness of all satellite loads prior to uploading.

TRD3.7.2.1.1-10 DELETED

TRD3.7.2.1.1-11 DELETED

TRD3.7.2.1.1-12 DELETED

TRD3.7.2.1.1-13
The MMC shall provide a trending analysis on any satellite telemetry over one orbit, day, week, month, or year.

TRD3.7.2.1.1-14
The MMC shall archive all commands and loads to the satellite and all telemetry received from the satellites for the life of the program.

TRD3.7.2.1.1-15
The MMC shall have the capability to support anomaly investigation and resolution analysis.

TRD3.7.2.1.1-16
The MMC shall provide mission operations guidance, including mission configuration, maneuver planning [including NPP sensor calibration maneuvers], satellite activity prioritization, and data handling.

TRD3.7.2.1.1-17
The MMC shall provide mission operations information to the operational and research communities in the form of regular mission reports, including operational metrics for the mission.

TRD3.7.2.1.1-18 DELETED

3.7.2.1.2 Satellite Operations

TRD3.7.2.1.2-1
The MMC shall provide pre-launch, launch, early orbit, and orbital support of the NPP and NPOESS satellites.

TRD3.7.2.1.2-2
The MMC shall support satellite alignment and sensor calibration activities.

TRD3.7.2.1.2-3 DELETED

TRD3.7.2.1.2-4 DELETED

TRD3.7.2.1.2-5 DELETED

TRD3.7.2.1.2-6 DELETED

TRD3.7.2.1.2-7 DELETED

TRD3.7.2.1.2-8 DELETED

TRD3.7.2.1.2-9 DELETED

TRD3.7.2.1.2-10 DELETED

TRD3.7.2.1.2-11 DELETED

3.7.2.1.3 Command Generation

TRD3.7.2.1.3-1
The MMC shall have the capability to schedule any command or load supported by the satellite referenced to absolute time.

TRD3.7.2.1.3-2
The MMC shall have the capability to generate any command or load supported by the satellite referenced to absolute time.

TRD3.7.2.1.3-3
The MMC shall have the capability to schedule any command or load supported by the satellite referenced to relative time.

TRD3.7.2.1.3-4
The MMC shall have the capability to generate any command or load supported by the satellite referenced to relative time.

TRD3.7.2.1.3-5 DELETED

TRD3.7.2.1.3-6 DELETED

TRD3.7.2.1.3-7
Any commands that involve irreversible or degrading actions shall require operator interaction or confirmation prior to the transmission of the commands.

TRD3.7.2.1.3-8 DELETED

TRD3.7.2.1.3-9 DELETED

TRD3.7.2.1.3-10 DELETED

TRD3.7.2.1.3-11 DELETED

3.7.2.1.4 C3 Databases

The MMC will have a number of data bases related to the satellite and IDP segment processing systems. These databases will have to be maintained at both the MMC and backup MMC.

TRD3.7.2.1.4-1
The MMC shall have a satellite command database.

TRD3.7.2.1.4-2
The MMC shall utilize a common telemetry database (conversion coefficients, limits) with other system areas (factory, launch support).

TRD3.7.2.1.4-3 DELETED

TRD3.7.2.1.4-4
Operational database changes at either MMC shall automatically be updated at the other MMC. [Not applicable to NPP.]

TRD3.7.2.1.4-5
The MMC shall archive all out of limit conditions and operator actions.

3.7.2.1.5 Telemetry Processing

TRD3.7.2.1.5-1
The system shall process all real-time telemetry from the Satellite or Satellite simulator in real-time.

TRD3.7.2.1.5-2
The MMC shall process all stored telemetry from the satellite.

TRD3.7.2.1.5-3 DELETED

TRD3.7.2.1.5-4
The MMC shall notify the operator of any satellite out-of-limit conditions through flags, alerts, or other means.

TRD3.7.2.1.5-5 DELETED

TRD3.7.2.1.5-6
The MMC shall verify that all flight software, command, and database loads transmitted to the satellite have been received and provide a positive or negative response.

TRD3.7.2.1.5-7 DELETED

TRD3.7.2.1.5-8 DELETED

TRD3.7.2.1.5-9
The MMC shall have the capability to perform memory content verification of all reprogrammable satellite computers.

TRD3.7.2.1.5-10
The MMC shall be capable of retrieving, processing, and trending archived telemetry data.

3.7.2.2 Environmental Support

Environmental data, analyses, alerts, advisories, and forecasts are required to support mission operations, satellite mission planning, launch support, satellite tracking, real-time decision making, anomaly resolution, and other operational activities.

TRD3.7.2.2-1
NPOESS shall use available space, near-earth, and terrestrial environmental data products in order to perform its mission.

3.7.2.3 Data Routing and Retrieval (DRR) Element

The DRR element provides all inter-element communications for the NPOESS system (C3S and the IDPS), which includes the routing (from ingest at the ground stations) of both stored telemetry and real-time telemetry to the MMCs and stored mission data to the IDPS Central element. Routine operations for data routing should be automatic.

TRD3.7.2.3-1 DELETED

TRD3.7.2.3-2
The DRR element shall provide routing for commands, mission planning requests, and any other communications between the MMC, ground stations, FVS Element, IDPS central element, and other external interfaces.

TRD3.7.2.3-3 DELETED

TRD3.7.2.3-4
Routine operations of the DRR element shall be automated.

TRD3.7.2.3-5 DELETED

3.7.2.4 Ground Station Element

C^3 resources/nodes that (1) meet NPOESS operational requirements, (2) are operated in accordance with appropriate international agreements or treaties between the US and the host nation, and (3) have a US government presence or an acceptable commercial contract in place, are considered under US control for the purposes of this program and may be used for normal NPOESS operations. The C3S may use space and/or ground assets as needed to meet the data availability and latency requirements. The C3S may use the NOAA's CDAs, the European ground station (Svalbard), McMurdo Bay, Antarctica, space relays (TDRSS), and/or other government or commercial data acquisition facilities. Any use of TDRSS will be governed by the IPO/NASA TDRSS MOA.

TRD3.7.2.4-1 DELETED

TRD3.7.2.4-2
If a C^3 resource/node does not meet the "US controlled" criteria defined in 3.7.2.4, then the overall C^3 architecture shall have sufficient capability to meet the threshold NPOESS requirements without reliance on any one such resource/node (e.g., a single non-US controlled node becomes unavailable for operations). [Not applicable to NPP.]

TRD3.7.2.4-3
The system shall provide satellite data recovery operations and satellite commanding operations without intervention from the on-site ground station staff.

3.7.2.5 Flight Vehicle Simulator Elements

The Flight Vehicle Simulator (FVS) should provide an interactive high fidelity simulation of the spacecraft and its critical sensors. It should utilize flight-like hardware for critical elements, flight software, and the spacecraft processor. The FVS should include dynamic modeling of spacecraft performance.

TRD3.7.2.5-1
The NPOESS FVS shall be capable of simulating all of the NPOESS satellites. [Not Applicable to NPP.]

TRD3.7.2.5-2 DELETED

TRD3.7.2.5-3
The control workstation for the FVS element shall be capable of executing scenarios for training, emergency procedures, and flight and ground software test and certification.

TRD3.7.2.5-4
The FVS element shall be modular and provide for growth in functions and data throughput. [Not applicable to NPP.]

TRD3.7.2.5-5
The FVS element at each MMC shall provide the capability to verify all uploads.

TRD3.7.2.5-6
The FVS element at each MMC shall be remotely operable from the other MMC. [Not Applicable to NPP.]

TRD3.7.2.5-7
The NPP FVS shall be capable of simulating the NPP satellite.

3.7.2.6 C3S Inter-Element Interface Requirements

TRD3.7.2.6-1 DELETED

TRD3.7.2.6-2 DELETED

TRD3.7.2.6-3 DELETED

3.7.3 Interface Data Processor Segment

TRD3.7.3-1
The IDPS shall geolocate all NPOESS EDRs in geodetic latitude and longitude corrected for height.

TRD3.7.3-2
The design of the IDPS shall permit the use of ancillary data sources as required to generate all Data Products specified in Appendix E.

TRD3.7.3-3
Each IDPS element shall have a data management system to provide access to RDRs, SDRs, TDRs, EDRs, and associated data.

TRD3.7.3-4
Based on calibration information, the IDPS shall correct the xDR data to meet the requirements of Appendix D.

TRD3.7.3-5 DELETED

TRD3.7.3-6 DELETED

TRD3.7.3-7 DELETED.

TRD3.7.3-8
The IDPS shall provide automatic reconfiguration capability in response to planned sensor configurations or sensor flight software changes.

TRD3.7.3-9
The IDPS shall monitor transmission data quality and quantity and provide reports to the C3S.

TRD3.7.3-10
The IDPS shall accept a reshipment of the satellite mission data transmission from C3S and update missing or corrupted data.

TRD3.7.3-11
The IDPS shall accept shipments of ancillary, calibration, and similar data, to include NPOESS archived data, from the Centrals.

TRD3.7.3-12 DELETED

TRD3.7.3-13 DELETED

TRD3.7.3-14
The system shall provide geolocation accuracy for each EDR in accordance with Appendix D, accounting for satellite position and attitude, sensor characteristics, earth geoid, and other factors as required.

TRD3.7.3-15
The IDPS shall use WGS84 (see NIMA TR-8350.2) for the reference ellipsoid.

TRD3.7.3-16
The design of the IDPS shall provide the capability for each Central to designate substitute sources of ancillary data to be used to produce additional Data Products. The system may use the resource reserves specified in 3.2.8.1.2 to accomplish these products.

3.7.3.1 IDPS Central Element

The IDPS components at Centrals should adhere to a common system architecture with common system software and, if applicable, common hardware.

TRD3.7.3.1-1 DELETED

TRD3.7.3.1-2 DELETED

TRD3.7.3.1-3 DELETED

TRD3.7.3.1-4 DELETED

TRD3.7.3.1-5 DELETED

TRD3.7.3.1-6
The IDPS shall be capable of accepting all SMD data delivered from the C3 segment.

TRD3.7.3.1-7
The IDPS shall have the capability to store NPOESS and NPP RDRs, SDRs, TDRs, and EDRs for at least 24 hours following data availability to the host user interface.

TRD3.7.3.1-8
SDRs, TDRs, and other intermediate products (e.g., cloud mask) shall be available as internal retrievable data records.

TRD3.7.3.1-9 DELETED

TRD3.7.3.1-10 DELETED

TRD3.7.3.1-11 DELETED

TRD3.7.3.1-12
If needed to satisfy the requirements of this TRD, the IDPS shall process those METOP data files (as primary, ancillary, or auxiliary data) required to deliver the METOP equivalent of the NPOESS xDRs.

TRD3.7.3.1-13
Where METOP products are substituted for NPOESS products, the degradation in the product attributes from NPOESS requirements, if any, shall be specified. [Not applicable to NPP]

TRD3.7.3.1-14 DELETED

TRD3.7.3.1-15
The system shall provide an algorithm support capability. This capability is intended to support the evolution of scenario specific algorithms, as well as the evolution of new algorithms as the NPOESS capabilities and underlying science become better understood. This support element should be capable of capturing NPOESS data sets and other IDPS-like capabilities such that scientific and engineering algorithm development can proceed, in parallel with

normal operations, and prototype algorithms can be simulated and tested in real-time in a full operational environment. Any hardware and software required for this capability is in addition to the 100% growth margin over the "base resource" required by TRD3.2.8.1.2-1.

TRD3.7.3.1-16 DELETED

TRD3.7.3.1-17
The IDPS shall provide graceful xDR product performance degradation in response to space segment degradation or unavailable ancillary data.

3.7.3.1.1 DELETED

TRD3.7.3.1.1-1 DELETED

TRD3.7.3.1.1-2 DELETED

TRD3.7.3.1.1-3 DELETED

TRD3.7.3.1.1-4 DELETED

3.7.3.1.2 DELETED

TRD3.7.3.1.2-1 DELETED

TRD3.7.3.1.2-2 DELETED

3.7.3.1.3 IDPS Resource Management

TRD3.7.3.1.3-1
The IDPS shall provide the capability to manage, schedule and control data processing, redundancies, and resources.

TRD3.7.3.1.3-2
The system shall monitor the segment performance and data quality.

TRD3.7.3.1.3-3
The IDPS shall generate and transfer mission reports to the C3 which contain performance statistics, volume of data received, processed, and transferred to the Centrals.

TRD3.7.3.1.3-4 DELETED

TRD3.7.3.1.3-5
The IDPS shall be capable of receiving and processing NPP data without interfering with the NPOESS operational satellite processing.

TRD3.7.3.1.3-6 DELETED

TRD3.7.3.1.3-7
The IDPS shall provide RDR, SDR, TDR, and EDR metadata containing configuration identification, processing history, and mission data format information as required in the IDPS ICDs.

TRD3.7.3.1.3-8
The IDPS shall have a database of sensor and spacecraft housekeeping telemetry required for mission data processing.

TRD3.7.3.1.3-9
The IDPS shall have a database of calibration parameter information for each sensor required for mission data processing.

TRD3.7.3.1.3-10
The IDPS shall have a database of satellite attitude and position information required for mission data processing.

TRD3.7.3.1.3-11 DELETED

TRD3.7.3.1.3-12
The IDPS shall provide sensor data quality analysis functions to measure and track sensor performance, such as channel-to-channel registration, and sensor noise figures.

TRD3.7.3.1.3-13
The IDPS shall alert the operator to out of specification performance.

3.7.3.2 DELETED

TRD3.7.3.2-1 DELETED

TRD3.7.3.2-2 DELETED

3.7.3.2.1 DELETED

TRD3.7.3.2.1-1 DELETED

TRD3.7.3.2.1-2 DELETED

TRD3.7.3.2.1-3 DELETED

3.7.3.2.2 DELETED

TRD3.7.3.2.2-1 DELETED

TRD3.7.3.2.2-2 DELETED

TRD3.7.3.2.2-3 DELETED

TRD3.7.3.2.2-4 DELETED

3.7.3.2.3 DELETED

TRD3.7.3.2.3-1 DELETED

TRD3.7.3.2.3-2 DELETED

TRD3.7.3.2.3-3 DELETED

3.7.4 Launch Support Segment

TRD3.7.4-1
The LSS shall have the capability to perform the required tests and operations necessary to successfully support the launch of an NPOESS satellite into orbit. [Not applicable to NPP.]

TRD3.7.4-2
The LSS shall provide access to the satellite for launch processing, servicing, and maintenance. [Not applicable to NPP.]

TRD3.7.4-3 DELETED

TRD3.7.4-4
The LSS shall support post-launch operations at the launch base. [Not applicable to NPP.]

TRD3.7.4-5
The LSS shall support satellite command simulation and testing. [Not applicable to NPP.]

3.7.4.1 Ground Support Equipment (GSE)

TRD3.7.4.1-1
The LSS shall include the necessary launch base Ground Support Equipment (GSE) and software for the completion of launch operations. [Not applicable to NPP.]

TRD3.7.4.1-2
The factory handling, carting, and LV mating equipment shall be designed for safe shipping, handling, and transportation of the satellite vehicle and associated equipment. [Not applicable to NPP.]

3.7.5 Field Terminal Segment

TRD3.7.5-1
The Field Terminal software, when installed and operating on the specified field terminal hardware, shall process EDRs as specified in Appendix E within [TBD] minutes (10 minutes objective) after loss of signal. [Not applicable to NPP.]

TRD3.7.5-2
The Field Terminal software, when installed and operating on the specified field terminal hardware, shall have imagery data, including SDRs, available for display within 2 minutes after receipt of data. [Not applicable to NPP.]

TRD3.7.5-3
When the satellite is in the normal operational mode, or when it has been commanded from the ground into the selective data encryption mode, the Field Terminal software shall process the EDRs to the performance specification in Appendix D if the specified hardware is installed in the HRD terminal and ancillary data is available. [Not applicable to NPP.]

TRD3.7.5-4
The system shall document any performance degradation of products at HRD terminals, including the cause of degradation (e.g., lack of ancillary data, entering selective data encryption mode under the constraints of 3.2.1.9-4, etc.). [Not applicable to NPP.]

TRD3.7.5-5
The Field Terminal software shall have a field terminal version that will process the LRD data into the EDRs specified in Appendix E with the threshold values of Appendix D as the objective for those EDRs. See TRD3.2.1.2.2.2 for clarification of LRD link contents and quality. [Not applicable to NPP]

TRD3.7.5-6 DELETED

TRD3.7.5-7 DELETED

TRD3.7.5-8
The EMD contractor shall specify the on-line storage required by the HRD field terminal to store and have available for retrieval, the RDRs, SDRs, TDRs, and EDRs as specified in Appendix E for the last 24 (TBR) hours. [Not applicable to NPP.]

TRD3.7.5-9
The EMD contractor shall specify the on-line storage required by the LRD field terminal to store and have available for retrieval the RDRs, SDRs, TDRs, and EDRs as specified in Appendix E for the last 24 *(TBR)* hours. The IDP field terminal software may use compression techniques on all but the most recent pass to meet the storage requirement. [Not applicable to NPP.]

TRD3.7.5-10
The EMD contractor shall specify the characteristics of the LRD and HRD field terminal antenna and receivers required to receive the NPOESS LRD and HRD data streams. [Not applicable to NPP]

TRD3.7.5-11
The EMD contractor shall specify the characteristics of the LRD and HRD field terminal hardware/software required to host the NPOESS LRD and HRD processing software, and decrypt the data stream when necessary. [Not applicable to NPP]

4. VERIFICATION AND QUALITY ASSURANCE PROVISIONS

TRD4-1
MIL-STD-1540C (tailored) shall be used as a guide for the NPOESS Space Segment verification and test program.

4.1 General Requirements

4.1.1 Verification

TRD4.1.1-1
The system shall be designed so that all requirements contained herein can be verified as specified in Sections 4.2 and 4.3 below.

TRD4.1.1-2
Each verification shall be carried out in accordance with approved procedures. (See applicable contract requirements to determine which procedures require government approval). In the case of verification by test (as defined in 4.1.4.2 below), the procedure shall identify the specific test instrumentation (hardware and/or software) and/or special test equipment used.

TRD4.1.1-3
Requirements of Sections 3 shall be verified by the methods specified for each requirement in the contractor's System and Segment specifications as shown in the contractor's Verification Matrix.

TRD4.1.1-4
The verification methods used shall be in accordance with the methods specified in Section 4.1.4. Use of the term "Not Applicable" will be limited to those paragraph/paragraph headings for which there is no method of verification or where verification is accomplished in subparagraphs.

4.1.2 Quality Assurance

TRD4.1.2-1
Parts, materials, and manufacturing process controls that are necessary to meet the requirements of this specification shall be documented and applied during the manufacture of all items submitted to qualification and acceptance verification.

TRD4.1.2-2
Controls on instrumentation and equipment, including precision measuring equipment necessary to carry out the verifications required herein, shall be documented and applied during all applicable verification activities.

4.1.3 Records

TRD4.1.3-1
Complete records indicating relevant manufacturing and verification data, including the application of all parts, materials, and control requirements of 4.1.2 above, the verification procedures required by 4.1.1 above, and all nonconformance reports, if any, shall be maintained for the system items and made available for review during the service life of the system.

4.1.4 Verification Methods

4.1.4.1 Demonstration

Demonstration is an exhibition of the operability or supportability of an item under intended service use conditions. Sufficient data for requirements verification can be obtained by observing functional operation of the system, or a part of the system, without the use of instrumentation or special test equipment beyond that inherently provided in the system being verified. Demonstrations may be accomplished by computer simulation.

4.1.4.2 Test

Test is the verification method by which the operability, supportability, performance capability or other specified qualities of an item are verified when subjected to controlled conditions that are real or simulated. These verifications may require use of special test equipment and instrumentation that is not an integral part of the system being verified to obtain quantitative data for analysis, as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control.

4.1.4.3 Analysis

Analysis is the verification method used to verify requirements by determining qualitative and quantitative properties and performance of the system by studying and examining engineering drawings, software, and hardware flow diagrams, software and hardware specifications, and other software and hardware documentation (e.g., Commercial Off-the -Shelf (COTS) vendor documentation). It also includes performing modeling, simulation, and/or calculations and analyzing the results. Analysis techniques include interpretation or interpolation/extrapolation of analytical or empirical data collected under defined conditions or reasoning to show theoretical compliance with requirements.

4.1.4.4 Inspection

Inspection is the verification method used to verify characteristics of an item by inspecting engineering documentation produced during development or by inspection of the product itself to verify conformance with specified requirements. Inspection is nondestructive and consists of visual inspections or simple measurements without the use of precision measurement equipment.

For acceptance of an item, verification by inspection includes the assessment of similarity of the characteristics of subsequent items to the corresponding characteristics of the first item generated based on a common design.

4.1.4.5 Similarity

Similarity is the process of comparing a current item with a previous item, taking into consideration configuration, test data, application and/or environment. The evaluation should be documented and shall include: the test procedures/reports of the item to which similarity is claimed; a description of the difference(s) between the items; and the rationale for verification by similarity. All on orbit experience should be documented and available for review.

4.2 Qualification Requirements.

4.2.1 Qualification Of System Elements That Are Reused From Prior Designs.

Similarity analysis may be used in lieu of the test or demonstration methods for qualification of a system element when it can be shown that the item is identical in design to an item that has been previously qualified to equivalent or more stringent criteria.

TRD4.2.1-1
If similarity analysis cannot be used, qualification shall be in accordance with 4.2.2 below.

4.2.2 System Element Qualification.

TRD4.2.2-1
Each verification shall be carried out in accordance with a verification procedure approved in accordance with all applicable provisions of the contract.

TRD4.2.2-2
In the case of verification by test, the procedure shall identify the test instrumentation (hardware and/or software) and/or special test equipment used.

TRD4.2.2-3
One NPOESS flight unit (usually the first) will be subjected to protoqualification level testing.

TRD4.2.2-4
The EMD contractor shall verify the adequacy of any protoqualification testing performed on the sensor subsystems by the instrument contractors and supplement that testing as needed.

4.3 Acceptance Requirements.

4.3.1 Vehicle Acceptance

TRD4.3.1-1
The space vehicle acceptance criteria shall verify that all vehicle performance requirements in Section 3 have been satisfied. Methods including demonstration, test, inspection, analysis and document review will be utilized to verify fulfillment of the performance requirements.

TRD4.3.1-2
After protoqualification level testing has been completed, subsequent flight units shall be acceptance level tested.

4.3.2 Ground Equipment Acceptance

TRD4.3.2-1
The ground equipment acceptance criteria shall verify that all performance requirements in section 3 have been satisfied. Methods including demonstration, test, inspection, analysis and document review will be utilized to verify fulfillment of the performance requirements.

4.3.3 Launch, Early Orbit Testing, and Anomaly Resolution

TRD4.3.3-1
Launch and early orbit testing shall be conducted by the contractor on all satellites according to Government approved test plans in order to demonstrate operational readiness.

4.3.4 System Acceptance

TRD4.3.4-1
The EMD contractor shall certify system readiness to begin dedicated OT&E and will use the process outlined in AFM 63-119, *Certification of System Readiness for Dedicated Operational Test and Evaluation*.

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5. PREPARATION FOR DELIVERY

5.1 PRESERVATION AND PACKAGING

TRD5.1-1
Deliverable items shall be packed and handled in such a manner as to protect them against vibrations, shocks, moisture, and contamination associated with ground or air transport.

TRD5.1-2
Protection shall be provided against natural environmental conditions using containers, shrouds, or covers.

TRD5.1-3
Access provisions for inspection and handling shall be incorporated for all deliverable items.

TRD5.1-4
A positive means to verify compliance with shock, temperature, and moisture requirements shall be included with all deliverable items.

5.2 MARKINGS

TRD5.2-1
Nameplates for hardware shall contain the item or configuration item number, serial number, lot number (or contract number), manufacturer, and nomenclature.

TRD5.2-2
Software media shall be marked to display software configuration item number, serial number, contract number, manufacturer, and nomenclature.

6. NOTES

6.1 INTENDED USE

The System is intended for use in the National Polar-orbiting Operational Environmental Satellite System to support worldwide DoD and civilian operations.

APPENDIX A

DEFINITION/GLOSSARY OF TERMS

APPENDIX A DEFINITION/GLOSSARY OF TERMS

10.1 The following are general definitions used throughout the NPOESS program. Please refer to the applicable requirements document(s) on your contract for a more detailed explanation of the terms which affect your specific application.

Absolute humidity

The mass of water vapor per unit volume of moist air expressed in grams per cubic centimeter.

Air Force Satellite Control Network (AFSCN)

A collection of ground stations operated by the Air Force around the world.

Airglow

A natural electromagnetic radiation arising from chemical reactions of upper atmospheric constituents. Airglow occurs as emission continua, atomic lines, and molecular bands, with the brightest contributions arising from atomic oxygen and OH. Airglow extends from the ultraviolet, through visible, to the SWIR spectrum, occurs in the 70-300 km altitude range, and is both temporally and spatially variable.

Albedo (Surface)

The ratio of the solar electromagnetic power in a specified band reflected from a surface element of the earth to the total in-band power incident upon it.

Ancillary Data

Any data which is not produced by the NPOESS System, but which NPOESS EDR algorithms require to meet the EDR attributes given in the TRD Appendix D (e.g., terrain height database or conventional surface and upper air observations).

API (Antecedent Precipitation Index)

An estimate of surface moisture based on rainfall history. API includes both surface water and soil moisture. Soil moisture (columnar %) may be computed from API by dividing API by the depth of the soil (in mm), to yield the equivalent vertical mm of water per unit vertical mm depth of soil. Soil moisture (% by weight) may be computed from API by dividing API by the soil bulk density (requires knowledge of soil type).

Argos

A satellite-based location and data collection system dedicated to monitoring the environment.

Atmosphere-centimeter (atm-cm)

Read as atmosphere-centimeter, atm-cm denotes the amount of a gas in a vertical column from the earth's' surface to space. It is the thickness of the slab of gas, in centimeters, if all the gas were concentrated in a layer at a pressure of atmosphere.

Autonomous Operations

Operations which occur automatically; without human intervention.

Auxiliary Data

Data produced by the NPOESS system, other than sensor data, which NPOESS algorithms require to achieve the performance attributes given in the TRD Appendix D (e.g., ephemeris data, sensor calibration coefficients, sun angles).

C^3 Segment

The system segment responsible for Command, Control, and Communications.

Centrals

Primary processing centers that use NPOESS RDRs and/or EDRs, and other data to produce environmental products for their customers. The processing, archiving, and dissemination of these data is their responsibility. For NPOESS, the following are Centrals: Air Force Weather Agency (AFWA), Fleet Numerical Meteorology and Oceanography Center (FNMOC), the Naval Oceanographic Office (NAVOCEANO), and National Environmental Satellite, Data, and Information Service (NESDIS)/National Center for Environmental Prediction (NCEP).

Climate Data Record (CDR)

Climate data records are products of the science processing segment only and are science products that are different from or further processed than the operational EDRs. CDRs are products generated from Level 2 processing or higher.

Closest Point to Shore

Distance from a coastline with smooth topography along a perpendicularly intersecting ground track. Closest point is the distance at which 65% of the altimeter data is in fine track mode for satellite passes approaching land and 50% of the altimeter data is in fine track mode for satellite passes receding from land. For coastal values, radiometric corrections are not required within 40 km of shore.

Cloud

An aggregate of minute non-precipitating water and/or ice particles in the atmosphere above the earth's surface. “Cloud” is always to be interpreted to mean “detectable cloud,” as defined in this glossary.

Cloud cover

The fraction of a given area overlaid in the local normal direction by clouds. It is the portion of the earth's horizontal surface masked by the vertical projection of clouds.

Cloud type

The classification of clouds into the types given in Tables 3-19 and 3-20 of the Federal Meteorological Handbook 1B.

Coastal

Coastal coverage refers to the areal extent consistent with the US Exclusive Economic Exploitation Zones (EEZs), which extend 200 nm from shore. Coastal coverage shall entail roughly 300 swath coverage, but pertains to all coasts worldwide to support civil and military observations.

Common Support Equipment (CSE)

Support equipment capable of common use by various systems throughout DOD, NOAA, and NASA, as applicable.

Communications Security (COMSEC)

Measures and controls taken to deny unauthorized persons information derived from telecommunications and ensure the authenticity of such telecommunications. NOTE: Communications security includes cryptosecurity, transmission security, emission security, and physical security of COMSEC material.

Computer Security (COMPUSEC)

Measures and controls that ensure confidentiality, integrity, and availability of the information processes and stored by a computer.

Co-Registration of Spectral Bands

Co-registration of spectral bands is measured by the displacement of corresponding pixels in two different bands from their ideal relative location. Two pixels are "corresponding" if their footprints should ideally coincide or if the footprint of one should ideally lie within a specific region of the footprint of the other. If co-registration is specified by a single value, this value is the upper bound on the magnitude of the displacement of the locations of corresponding pixels in any direction.

Critical Failure

Any fault, failure or malfunction which results in the loss of the System's ability to meet the requirements of any key attribute of a key EDR or other key performance parameter (e.g., data access).

Design Service Life

The design service life of the satellite is at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency time. It includes the 7 year on-orbit design life and up to 3 years of intermittent testing..

Detectable Cloud

An aqueous aerosol having a vertical extinction optical depth exceeding 0.03 (*TBR*) in the visible or a contrast with the background exceeding 0.02 (*TBR*) in the visible. Contrast with the background is defined as the difference between the cloud and adjacent background radiance divided by the sum of these two radiances. "Cloud" is always to be interpreted to mean "detectable cloud."

Direct Mode Data Message (DMDM)

A short text message to be included with real-time broadcasts for notification to users of Spacecraft data status.

DOC Field Terminals

DOC sites are Anchorage, AK, Honolulu, HI, Miami, FL, Monterey, CA, and Chanhassen, MN.

Drop Size Distribution

The number of aerosol, cloud, or rain droplets per specified size interval per unit volume over a specified range of sizes.

Electron Density Profile

The density of free electrons as a function of altitude. It is generally derived from both ionospheric sounding data and theory.

Electronic Counter-Countermeasures (ECCM)

Measures taken to counter electronic warfare susceptibility and vulnerability of a specific system.

Environmental Data

Environmental data (also termed "mission data") refers to all data: atmospheric, oceanographic, terrestrial, space environmental, and climatic, being sensed and collected by the satellite or derived, at least in part, from these measurements.

Environmental Data Records (EDRs)

Data records produced when an algorithm is used to convert Sensor Data Records (SDRs) to geophysical parameters (including ancillary parameters, e.g., cloud clear radiation, etc.).

Equatorial Track Spacing

The maximum distance along the equator between adjacent ascending sea surface height profiles after the Exact Repeat Period.

Exact Repeat Period

Same as Refresh (time period for the ground trace to repeat), with the additional specification that the satellite nadir point must be no further than 1 km from the nominal reference ground track at all times.

Field Terminals

Field Terminals include the various receivers used by deployed/remote units to obtain environmental data in real time.

First-year ice

Sea ice of not more than one winter's growth, developing from young ice; thickness 30 cm- 2 m. May be subdivided into thin first-year ice / white ice, medium first-year and thick first-year ice.

Full Operational Capability

The System full operational capability (FOC) will be met when: a full NPOESS satellite constellation meeting all contractual system requirements is operational; sufficient C3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C3S, data recovery, and IDPS operations; and approval to operate at the secondary SOC is received.

Full Mission Capability

The full mission capability exists when: a full satellite constellation is operational (currently anticipated to be two US and one METOP); sufficient C3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C3, data recovery, and the IDP segment; and approval to operate at the secondary SOC received.

Geoid

The gravitational equipotential surface corresponding to mean sea level.

Geomagnetic Field

The magnetic field of the Earth.

Global Coverage

Global coverage denotes the observation of all points on the Earth or its atmosphere (with the exception of gaps centered over the poles consistent with the allocated swath width), at least once per given time period.

Global Positioning System (GPS)

A constellation of satellites broadcasting position and time reference information.

Goal

A "goal" value for a specified parameter is the minimum (maximum) of the range of preferred values for the parameter, where lower (higher) values of the parameter provide better performance or are otherwise more desirable. A design value falling between the target and goal values is desired by the government, and a value closer to the goal than the target is generally preferred, depending upon the impacts associated with approaching the goal. (See "target".)

Grey ice

Young ice 10-15 cm thick. Less elastic than nilas and breaks on swells. Usually rafts under pressure.

Grey-white ice

Young ice 15-30 cm thick. Under pressure more likely to ridge than to raft.

Haze

Fine dust, salt particles, smoke, or water particles (finer and more scattered than those of fog) dispersed though a part of the atmosphere, causing a lack of transparency of the air (which assumes a characteristic opalescent appearance that subdues all colors) and reducing the horizontal visibility of distant objects to more than one but less than two kilometers.

High Data Rate

Refers to the real time data link to field terminals which contains data at all channels (TBR) at the smallest scale horizontal spatial resolution (or cell size) required in TRD Appendix D.

Horizon

The actual lower boundary of the observed sky or upper outline of terrestrial objects including nearby natural obstructions.

Horizontal Cell Size

For a parameter which is an estimate of the uniform spatial average of an environmental parameter over a square region of the earth's surface or within a square layer of the atmosphere, the side length of this square region or layer. (For a parameter which is an estimate of an environmental parameter at a point, the horizontal cell size is defined to be zero.) For a reported parameter not of this type but which is defined for a square region of the earth's surface or a square layer of the atmosphere (e.g., cloud cover, ice concentration, etc.), the side length of this square region. (See the CrIS Unique SRD Para 3.2.1.1.1.1 for a CrIS-unique definition.)

Horizontal Coverage

The horizontal spatial extent of the region within which estimates of an environmental parameter are made and reported.

Horizontal Reporting Interval

The spacing between nearest neighbor points in the horizontal direction at which an environmental parameter is estimated and reported. For atmospheric profiles, the horizontal reporting interval applies to the lowest altitude samples. (See the CrIS Unique SRD Para 3.2.1.1.1.1 for a CrIS-unique definition.)

Horizontal Spatial Resolution

For a scanning imager on a space-based platform, a specified band, and a specified nadir angle, one half of the wavelength corresponding to the earth surface spatial frequency at which the end-to-end system modulation transfer function (MTF) equals 0.5 on the in-track spatial frequency axis or cross-track spatial frequency axis, whichever is greater. The in-track (cross-track) spatial frequency is the earth surface spatial frequency associated with the in-track (cross-track) direction. "End-to-end" in this definition means from photons collected by the sensor to calibrated radiances provided as part of the explicit Imagery EDR or within SDRs used to generate other EDRs. The effects of all signal and data processing functions performed in the course of generating these calibrated radiances, e.g., sample aggregation, re-sampling, image enhancement, image restoration, etc., are included in the HSR. (See definition of Modulation Transfer Function.)

Horizontal Wind Vector Accuracy

The wind speed error is $[[W_m]-[W_t]]$ where W_m is the measured velocity and W_t is the true velocity. The wind direction error is the angular difference between the directions of each component.

Housekeeping

Functions such as orbit and attitude maintenance, navigation, power, command, telemetry and data handling, structure, rigidity, alignment, heater power, temperature measurements, etc.

Ice free

No ice present. If ice of any kind is present, this term should not be used.

Imagery

Two-dimensional array of numbers, in digital format, each representing the brightness of a small elemental area.

Information Exchange Requirements (IER)

Identify the elements of war-fighter information used in support of a particular activity and between any two activities.

Information Systems Security (INFOSEC)

The protection of information systems against unauthorized access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorized users or the provision of service to unauthorized users, including those measures necessary to detect, document, and counter such threats.

Initial Operating Capability

IOC has been met when: two satellites are operational; sufficient C3 and mission data recovery resources are available to allow all mission data to be processed at all Centrals and 50 percent of field terminals; sufficient crews are trained to allow 24 hours/day, 365 days/year operations at the primary SOC, and to allow backup operations as needed; sufficient sustaining engineering resources are in place to allow for anomaly resolution, for example; sufficient logistics resources are in place to support C3, data recovery, and the IDP segment; and approval to operate at the secondary SOC is received.

Insolation

The solar radiation flux at the surface of the earth.

Interface Data Processor Segment (IDPS)

The NPOESS ground processing capability located at the Centrals. The IDPS receives RDRs from the Space or C^3 segment, temporarily stores RDRs, converts RDRs into EDRs (at DoD sites) then pushes all required data into the Central's computers. Field Terminal data processing will perform a subset of the functions of the Centrals IDPS as necessary to meet global user requirements.

Interoperability

The condition among communications-electronics systems or items of communications-electronics when information or services can be exchanged directly and satisfactorily between them and/or their users.

In-Track Resolution

Resolution of in-situ measurements along the orbital path, determined by sampling frequency.

Ionospheric Scintillation

The random fluctuation of the amplitude and phase of a radio-frequency signal caused by passing through the ionosphere.

Key Attribute

An EDR attribute that is a key performance parameter of the system. See Key Parameter.

Key EDR

An EDR which has a key attribute. See Key Attribute.

Key Parameter/Key Performance Parameter (KPP)

A parameter so significant that failure to meet the threshold requirement(s) pertaining to its measurement is cause for the System to be reevaluated or the program to be reassessed or terminated. Key parameters include key

attributes of key EDRs and the data access requirement. Key parameter requirements are to be included in the Acquisition Program Baseline. (The term "Key Performance Parameter" is used in the IORD.)

Key Sensor

A sensor which is required to meet key performance parameter requirements.

Latency (Data Latency)

The period from the time of observation of the last requisite data by the satellite until the EDR produced by that data is available at the IDPS/Central interface.

Lead

Any fracture or passageway through sea ice which is navigable by surface vessels.

Line Replaceable Unit

The smallest unit that can be removed and replaced without cutting or desoldering connections.

Local Average Revisit Time

The average time interval between consecutive measurements of a parameter at a given location on the earth's surface over a time period much greater than an orbital period. Local average revisit time so defined is a function of location on the earth's surface.

Local Refresh

The maximum time interval between consecutive measurements of a parameter at a given location on the earth's surface over a time period much greater than an orbital period. Local refresh so defined is a function of location on the earth's surface.

Local Revisit Time

The time interval between consecutive measurements of a parameter at a given location on the earth's surface. In general, successive revisit times at the same location will not be equal, and the distributions of revisit times during a given period of time at different locations will be different.

Local Time Range

For an in-situ/in-track measurement, range or ranges of ascending/descending times within which NPOESS spacecraft should be capable of measuring an EDR. Measurements outside of the specified range or ranges are not required.

Long-term Stability

The difference between the maximum and minimum short-term means of an estimated parameter over the NPOESS life cycle. This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation. The short-term mean is defined as the mean of a set of estimates of the parameter satisfying the following three conditions:

(1) The physical measurements on which the estimates are based, at least in part, are performed within a time period not exceeding 30 (TBR) days. (This time limit does not apply to databases or other ancillary data sources which may be used to generate the estimate.)
(2) The set is large enough so that the sample size error (see definition) in the short-term mean is much smaller than the specified long-term stability value.
(3) The true value of the parameter is the same for all estimates in the set.

The third condition is imposed because a long-term stability requirement must be met for any true value of the parameter within the measurement range (see definition), not in an average sense over the measurement range. In practice, such as in the analysis of simulation results or measured calibration/validation data, it is understood that measurements will be binned into sets for which the true value of the parameters falls into a narrow range, preferably a range much smaller than the required measurement range. Corrections for known temporal changes in sensor performance characteristics and for differences in sensor performance characteristics from satellite to satellite

are considered to be part of the parameter estimation process. Retrospective processing and re-analysis of data is allowed for the purpose of meeting a long-term stability requirement.

The long-term stability ρ is given by the following formula:

$$\rho = \max\{\mu_N(t)\}_{0\le t\le T-T'} - \min\{\mu_N(t)\}_{0\le t\le T-T'},$$

where: $\mu_N(t)$ is the short-term mean at time t, T is the NPOESS life cycle, T' is the maximum duration of the period during which measurements contributing to the short-term mean are performed, and the minimum and maximum are taken over the time period from t = 0, which is defined to be the beginning of the NPOESS life cycle, to t = T - T'.

The short-term mean $\mu_N(t)$ is given by the following formula:

$$\mu_N(t) = (\Sigma_{i=1,N}\ x_i(t'))/N\ , \quad 0 \le t \le T - T',$$

where: $x_i(t')$ is the value obtained in the i'th estimate of the parameter at time t', $\Sigma_{i=1,N}$ denotes summation from i = 1 to i = N, and $t \le t' \le t + T'$. The value of N is large enough so that the sample size error is much less than the required long term stability value for any time t in the range $0 \le t \le T - T'$.

If long term stability is specified as a percentage, the percentage is with respect to the mean M_N of the short-term mean $\mu_N(t)$ over the NPOESS life cycle. M_N is given by the following formula:

$$M_N = (1/(T - T')) \int \mu_N(t)\, dt$$

where the integral is over the range $0 \le t \le T - T'$. Long term stability expressed as a percentage is given by:

$$100 \times \rho/M_N$$

where ρ is defined above.

Longwave Radiation

The radiation that is emitted by the Earth or the atmosphere. It is generally in the spectral wavelength interval between 4 and 50 micrometers.

Low Data Rate

Refers to real time data link to field terminals containing fewer channels and/or coarser resolution than the high data rate real time link.

Mapping Uncertainty

The RMS error (three sigma) in the geolocation of measured or derived data samples, expressed in geodetic coordinates, based on a large number of repetitions of the measurement and/or derivation. An "error" is defined as the difference between the measured or derived value and the true value of a parameter. Mapping uncertainty is due to the combined effect of all systematic and random errors affecting geolocation.

Maximum Local Average Revisit Time

The maximum value of local average revisit time over the set of all locations within a given area of the earth's surface. Unless otherwise specified, the area is defined to be the horizontal coverage region of the measured parameter. Where constraints on the area are specified, e.g., "clear," "cloudy," etc., the area is defined to be the sub-region of the horizontal coverage region satisfying the constraint.

Maximum Local Refresh

The maximum value of local refresh over the set of all locations within a given area of the earth's surface. Unless otherwise specified, the area is defined to be the horizontal coverage region of the measured parameter. Where constraints on the area are specified, e.g., "clear," "cloudy," etc., the area is defined to be the sub-region of the horizontal coverage region satisfying the constraint.

Mean Down Time (MDT)

Mean down time (MDT) is calculated as:

$$MDT = \frac{\text{total time down from downing events}}{\text{number of downing events}}$$

Mean Mission Duration

The integral of the reliability distribution R(t) evaluated from time (t) equals zero until 84 months. R(t) shall include the effect of all wearout items on the spacecraft.

Mean Time Between Critical Failure (MTBCF)

The total amount of mission time divided by the total number of critical failures during a stated series of missions. Mean time between critical failure (MTBCF) is calculated as:

$$MTBCF = \frac{\text{operating time}}{\text{number of critical failures}}$$

Mean Time Between Downing Events (MTBDE)

Mean time between downing events is calculated as:

$$MTBDE = \frac{\text{operating time}}{\text{number of downing events}}$$

Mean Time Between Failures (MTBF)

The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

Mean Time To Repair (MTTR)

The sum of corrective maintenance times at any specific level of repair divided by the total number of failures within an item repaired at that level during a particular interval under stated conditions.

Mean Time To Restore Functions (MTTRF)

Mean time to restore functions is calculated as:

$$MTTRF = \frac{\text{total time down from critical failures}}{\text{number of critical failures}}$$

Measurement Accuracy

The magnitude of the difference between the mean estimated value of a parameter and its true value (see definition). This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation. The mean is based on a set of estimates satisfying the following two conditions:

(1) The set is large enough so that the sample size error (see definition) in the measurement accuracy is much smaller than the specified measurement accuracy value.

(2) The true value of the parameter is the same for all estimates in the set.

The second condition is imposed because a measurement accuracy requirement must be met for any true value of the parameter within the measurement range (see definition), not in an average sense over the measurement range. In practice, such as in the analysis of simulation results or measured calibration/validation data, it is understood that measurements will be binned into sets for which the true value of the parameters falls into a narrow range, preferably a range much smaller than the required measurement range.

For an ensemble of N estimates of the parameter x, the measurement accuracy β_N is given by the following formula:

$$\beta_N = |\mu_N - x_T|$$

where: μ_N is the sample mean, x_T is the true value of the parameter, and |…| denotes absolute value. The sample mean μ_N is given by the following formula:

$$\mu_N = (\Sigma_{i=1,N}\ x_i)/N$$

where: x_i is the value obtained in the i'th estimate of the parameter x and $\Sigma_{i=1,N}$ denotes summation from i = 1 to i = N.

Measurement Accuracy ***(For Sea Surface Height EDR*****)**

Based on an average over the Nadir Resolution cell. Accuracy includes radial orbit determination as well as measured range corrections (wet troposphere, ionosphere) and model-based corrections (dry troposphere, sea state bias). The required accuracy and timeliness for Coastal/Mesoscale may be obtained by high-pass filtering the sea height profiles to remove radial orbit error, which has scales greater than 10,000 km. Note that the sea surface height data will be used to derive tidal constituent amplitudes/phases as well as to observe semiannual, annual, and interannual ocean signals. Consideration must therefore be given to the temporal sampling interval as it relates to tidal aliasing. See "On the choice of orbits for an altimetric satellite to study ocean circulation and the tides", J. Geophys. Res., 92, 11693-11707, 1987.

Measurement Error

The difference between the estimated value of a parameter and its true value. This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation.

The measurement error ε is given by:

$$\varepsilon = x_E - x_T$$

where: x_E is the estimate of the parameter x and x_T is its true value (see definition).

Measurement Precision

The standard deviation (one sigma) of an estimated parameter. This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation. The standard deviation is based on a set of estimates satisfying the following two conditions:

(1) The set is large enough so that the sample size error (see definition) in the measurement precision is much smaller than the specified measurement precision value.

(2) The true value of the parameter is the same for all estimates in the set.

The second condition is imposed because a measurement precision requirement must be met for any true value of the parameter within the measurement range (see definition), not in an average sense over the measurement range. In practice, such as in the analysis of simulation results or measured calibration/validation data, it is understood that measurements will be binned into sets for which the true value of the parameters falls into a narrow range, preferably a range much smaller than the required measurement range.

For an ensemble of N estimates of the parameter x, the measurement precision σ_N is given by the following formula:

$$\sigma_N = [\ \Sigma_{i=1,N}\ (x_i - \mu_N)^2/(N - 1)]^{1/2}$$

where: μ_N is the sample mean (defined in the definition of measurement accuracy), x_i is the value obtained in the i'th estimate of the parameter x, and $\Sigma_{i=1,N}$ denotes summation from i = 1 to i = N.

Measurement Precision ***(For Sea Surface Height EDR)***

The standard deviation from a linear fit to data at the Horizontal Reporting Interval within the Nadir Resolution cell. Precision does not include measured range corrections (wet troposphere, ionosphere), model-based corrections (dry troposphere, sea state bias), or radial orbit determination.

Measurement Range

Range of values over which a parameter is to be estimated while meeting all other measurement requirements. This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation.

Measurement Sample Size Error

The standard deviation of the finite sample mean (square root of the variance) over the infinite universal ensemble of possible measurements. The sample size error must be much smaller than the required value of accuracy for any simulation which purports to verify that the accuracy requirement is met.

Measurement Uncertainty

The root-mean-square (RMS) of the measurement errors (see definition) for an estimated parameter. This estimate may be the result of a direct measurement, an indirect measurement, or an algorithmic derivation. The measurement uncertainty is based on a set of estimates satisfying the following two conditions:

(1) The set is large enough so that the sample size error (see definition) in the measurement uncertainty is much smaller than the specified measurement uncertainty value.

(2) The true value of the parameter is the same for all estimates in the set.

The second condition is imposed because a measurement uncertainty requirement must be met for any true value of the parameter within the measurement range (see definition), not in an average sense over the measurement range. In practice, such as in the analysis of simulation results or measured calibration/validation data, it is understood that measurements will be binned into sets for which the true value of the parameters falls into a narrow range, preferably a range much smaller than the required measurement range.

As defined herein, measurement uncertainty is due to the combined effects of all systematic and random errors. Also, as a consequence of its definition, measurement uncertainty converges to the square root of the sum of the squares (RSS) of the measurement accuracy and precision in the limit of infinitely large sets of measurements.

For an ensemble of N estimates of a parameter x, the measurement uncertainty ξ_N is given by the following formula:

$$\xi_N = [\Sigma_{i=1,N} (x_i - x_T)^2/N]^{1/2}$$

where: x_i is the value obtained in the i'th estimate of the parameter, x_T is the true value of the parameter, and $\Sigma_{i=1,N}$ denotes summation from i = 1 to i = N.

Medium Expendable Launch Vehicle

This class of Launch Vehicle includes the Delta family.

Medium First- year Ice

First-year ice with a thickness of 70-120 cm.

Metadata

Information about data. Provides a description of the data including: instrument, type of data, location of data, and quality of data.

Mesh

A rectilinear (square) grid of lines which is superimposed upon a standard map projection. Current practice is to use a polar stereographic map projection for which each hemisphere is overlaid with a 512 x 512 square grid (called "eighth-mesh"), which is true at 60 degrees latitude, i.e., the quoted geographical grid size of the mesh (25 nmi) is true at 60 degrees latitude. A future upgrade would be the implementation of a sixteenth-mesh ("20 km") grid. ("Mesh" defined fields are also displayable as Mercator projection products.)

Meteorological Range (Rm)

An empirically consistent measure of the visual range of a target. It is defined as the distance at which optical intensity is diminished by 17 dB (or the transmittance is 0.02). Meteorological Range $\hat{E}$**(Rm)** $=\hat{E}3.912/a_O$, where a_O is the extinction coefficient. The extinction coefficient is defined by:

$$I(x) = I(0)\, e^{-x/a_O},$$

where: I(x) is the optical intensity at distance x.

Mid-latitudes

The set of all locations on the earth's surface between 20 and 50 degrees north latitude and between 20 and 50 degrees south latitude.

Mission Data

The combination of data provided by any of the mission sensors (i.e., environmental data) plus satellite orbit, attitude, and time tags. It does not include other sensors (i.e., SARSAT, ADCS) or telemetry.

Mission Lifetime

The duration of the on-orbit phase of the NPP satellite.

Mission Management

Overall mission operations management responsible for managing, tracking, reporting, and decision making aspects of activities throughout the mission lifetime; includes space and ground management and represents both Programs (EOS and NPOESS) in accomplishing mission objectives.

Mission Sensors

Any sensor on the spacecraft directly used to satisfy any of the EDR requirements of TRD Appendix D.

Mixing Ratio

In a sample of moist air, the mixing ratio is the ratio of the mass of water vapor to the mass of dry air. It is expressed in parts per thousand, usually grams of water vapor per kilogram of dry air.

Modulation Transfer Function (MTF)

The magnitude of the Fourier transform of the end-to-end system point spread function (PSF). The MTF is a function of two spatial frequencies associated with two orthogonal spatial directions, and is equal to one at the origin by virtue of the normalization condition on the PSF.

Moisture Profiles

Relative and absolute humidity - the mass of water vapor per unit volume of moist air.

Multi-year Ice

Old ice up to 3 m or more thick which has survived at least two summers' melt. Hummocks smoother than second-year ice, and the ice is almost salt free. Color, where bare, is usually blue. Melt pattern consists of large interconnecting irregular puddles and a well-developed drainage system.

Nephanalysis

Analysis of cloud cover in terms of type and amount.

Nilas

A thin elastic crust of ice, easily bending on waves and swell under pressure, thrusting in a pattern of interlocking "fingers". Has a matt surface and is up to 10 cm in thickness.

Not-to-Exceed

A "not-to-exceed" value for a specified parameter is the maximum acceptable value of the parameter

Objective

A requirement which is significantly more difficult to meet than the threshold requirement but which, if met, would greatly enhance the utility of the data to the users.

On-Orbit Design Life

The seven year period during which the satellite must meet all operational requirements.

Operational Availability

Operational Availability (A_O) is defined as the probability that a system is operable and ready to perform its mission at any given time. A_O is a function of mean time between critical failure (MTBCF) and mean time to restore functions (MTTRF) and shall be calculated as:

$$Ao = \frac{MTBCF}{MTBCF + MTTRF}$$

Operational Service Life

The period of time that the NPOESS system has to be fully operational after IOC.

Operations Security (OPSEC)

Actions taken or plans developed to protect information, classified or unclassified, which could reveal system plans, procedures, or missions.

Particle Size Parameter

The Angstrom wavelength exponent, alpha, defined as: $a = - \Delta \ln(\tau)/\Delta \ln(\lambda)$ where: tau is optical thickness, lambda is wavelength, ln denotes natural logarithm, and Δ denotes the difference between optical thickness measurements at two different wavelengths.

Parts per million by volume (ppmv)

Read as parts per million by volume, ppmv denotes volume mixing ratio, specifically the amount of gas in a sample of "air" under standard temperature and pressure. This is the volume of gas in a volume of air.

Payload

Used to refer to the combination of the mission sensors and the SDC and S&R sensors carried by the spacecraft. The term may also be used to refer to the satellite when it is still mated to the launch vehicle.

Peculiar Support Equipment (PSE)

Also called "unique". Support equipment especially designed for use with a specific system and usable only on that system.

Personnel Security

Procedures established to ensure that all personnel who have access to sensitive information have the required authority, as well as appropriate clearances, and the need-to-know for the information.

Pixel

Contraction of “picture element”. In general, a pixel is defined as the smallest unit of information in a grid cell map or image. As applied to VIIRS, a pixel is defined as an individual sample of measured scene data at the finest resolution of the instrument in the mode in which it is operating. A pixel may be generated from one or more detector samples by aggregation, re-sampling, and/or any other data processing operations consistent with meeting the explicit and derived requirements for pixel radiometric, spatial, and temporal response characteristics. However, re-sampling is allowed only if required to implement aggregation of pixels from multiple detector samples (TBR). Depending on the degree of processing applied to the raw detector samples, a pixel may be dimensionless, e.g., a “digital number”, or may have units of radiance or reflectance. The spatial extent on the ground of a pixel (or pixel footprint) is determined by the two-dimensional system point spread function (or point source response function) associated with the pixel. In particular, the pixel width in the in-track (cross-track) direction is given by the horizontal spatial resolution (HSR) in the in-track (cross-track) directions. (See “Horizontal Spatial Resolution” and

"Pixel Width".) The pixel location (or pixel footprint location) on the ground is the ground location at which the point spread function associated with the pixel has a maximum. (See "Pixel Location".)

Pixel Footprint

The region on the ground associated with, or predominantly contributing to, the pixel information. The location and spatial extent of the pixel footprint are determined by the system point spread function associated with the pixel. (See "Pixel Width" and "Pixel Location".)

Pixel Location (or Pixel Footprint Location)

The pixel location (or pixel footprint location) is defined as the point on the ground at which the system point spread function associated with the pixel has a maximum. If the point spread function achieves its maximum over a finite region rather than at a point, then the pixel location is the centroid of this region.

Pixel Width (or Pixel Footprint Width)

The pixel width in the in-track (cross-track) direction is defined as the horizontal spatial resolution (HSR) in the in-track (cross-track) direction. Other terms having the same meaning as "pixel width" are "pixel size", "pixel extent", "pixel dimension", and "pixel HSR".

Point Spread Function (PSF)

See System Point Spread Function.

Polarization Sensitivity (or Polarization Factor)

The polarization sensitivity (or polarization factor) (PF) is defined as:

$$PF = (I_{max} - I_{min})/(I_{max} + I_{min})$$

where
I_{max} = maximum measured radiance for linearly polarized source radiance for which the plane of polarization contains the line of sight and has any orientation about the line of sight.
I_{min} = minimum measured radiance for linearly polarized source radiance for which the plane of polarization contains the line of sight and has any orientation about the line of sight.

Precipitable Water

The total water vapor contained in a vertical column of unit cross-sectional area extending between any two specified levels, commonly expressed in terms of the height to which that water substance would stand if completely condensed and collected in a vessel of the same unit cross-section. The *total precipitable water* is that contained in a column of unit cross-section extending all of the way from the earth's surface to the "top" of the atmosphere.

Primary EDR

EDR for which a sensor contractor has been assigned primary sensor and algorithm development responsibility, either under all conditions or prescribed conditions (e.g., clear versus cloudy conditions). The algorithm may or may not require the use of additional data from other sensors for which the EDR is not primary.

Probability of Correct Typing

Probability that a horizontal cell reported as being of type x is in fact of type x, where x is any allowed type.

Probability of success (Ps)

The probability that a given segment, element, and/or component of the mission will continue to operate over a specified time. Typically applies to the launch vehicle and the Satellite.

Radiance Reference Levels

In the reference 0.4 - 1.0 μm bandpass, an overhead sun at nadir produces a radiance of 2.65×10^{-2} W/cm^2-sr at the location of the satellite for an earth surface albedo of unity; the radiance is 5.7×10^{-4} W/cm^2-sr when the terminator is at nadir.

Raw Data Records (RDRs)

Full resolution, digital sensor data, time-referenced and locatable in earth coordinates, with absolute radiometric and geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data should be unprocessed with the following exceptions: time delay and integration (TDI), detector array non-uniformity correction (i.e., offset and responsivity equalization), and lossless data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data will be retained and communicated to the ground without lossy compression.

Reflectance (Band Integrated, Top of the Atmosphere (TOA))

The band-integrated TOA reflectance ($\rho(\theta,\varphi;\theta_s,\varphi_s)$) is defined as follows:

$$r(q, j; q_s, j_s) = \frac{p \int_0^\infty L(q, j; l)\, R(l)\, dl}{\int_0^\infty E(l)\, R(l)\, dl\, \cos(q_s)}$$

where
θ = zenith angle of the observing sensor,
φ = azimuth of the observing sensor,
θ_s = zenith angle of the illuminating source (e.g., the sun or moon).
φ_s = azimuth of the illuminating source,
λ = wavelength,
$L(\theta,\varphi;\theta_s,\varphi_s)$ = TOA spectral radiance in the direction of the observing sensor,
$E(\lambda)$ = irradiance due to the illuminating source orthogonal to the line of sight to the illuminating source, $R(\lambda)$ = relative spectral response function of the sensor in the band of interest.
Unless otherwise indicated, the unmodified term “reflectance” as used in the SRD refers to the band-integrated, TOA reflectance defined above.

Refresh

The specified refresh thresholds represent the maximum value of the local average revisit time over the set of all locations on the Earth’s surface; where the local average revisit time represents the average time interval between consecutive measurements of a parameter at a given location on the Earth’s surface over a time period required for the ground trace to repeat.

Reporting Frequency

The mean time between successive reports of an EDR. Where reporting frequency is specified “per orbit” or “per satellite,” it is the mean time between successive reports of an EDR based on measurements from a single satellite. (Reporting frequency applies to EDR parameters that are not associated with localized portions of the earth's surface or a column of the atmosphere, e.g., in-situ measurements, solar irradiance measurements, etc. The times between consecutive observations of a parameter associated with a localized portion of the earth's surface or a column of the atmosphere are described by a constellation dependent distribution which varies from place to place. The attributes “maximum local average revisit time” and “maximum local refresh,” which are defined in terms of these earth location dependent distributions, are used for these EDR parameters.)

Revisit Time

The time interval between consecutive measurements of a parameter at the same location.

Root-Mean-Square Error (RMSE)

The root-mean-square error (RMSE) is defined as the square root of the sum of the squares of the measurement errors associated with a set of measurements or estimates. (See "measurement error".)

Safe Hold Mode

A nadir-facing, power-positive, and thermally safe mode.

Sample Size Error

The standard deviation of a function of a finite set of estimates of a parameter. These estimates may be the result of direct measurement, indirect measurement, or algorithmic derivation. The standard deviation is based on the ensemble of all possible finite sets of estimates. Sample size error is a measure of the width of the probability distribution of a function of a finite set of estimates.

If $\theta_N(x_1, x_2, \ldots, x_N)$ is a parameter depending on N estimates of a parameter x, i.e., $x_1, x_2, \ldots, x_N$, the sample size error is given by the following formula:

$$S_N = \langle (\theta_N(x_1, x_2, \ldots, x_N) - \langle \theta_N(x_1, x_2, \ldots, x_N) \rangle)^2 \rangle^{1/2}$$

where: $\langle \ldots \rangle$ denotes the expectation value over the ensemble of all possible sets of N estimates of x.

The measurement accuracy, precision, uncertainty, and short-term mean (see definition of long term stability) are all examples of functions of a finite set of estimates of a parameter.

Satellite

The spacecraft and its sensor payload.

Satellite Nadir Resolution

Resolution along satellite's nadir path.

Scene Albedo

The ratio of the amount of visible spectrum electromagnetic radiation returned to space by scattering and reflection from a given aerial region of the Earth's surface, atmosphere, and clouds, to the amount of visible spectrum electromagnetic energy incident upon that region.

Sea Ice Properties

Ice properties of the polar regions, including concentration, thickness, age, lead concentration, polynya concentration, iceberg distribution, etc.

Sea Surface Height/Topography

The height of the sea surface relative to the center of mass of the earth.

Secondary EDR

EDR for which a sensor may provide data as a secondary input to an EDR algorithm assigned as a primary EDR to another sensor contractor, either under all conditions or prescribed conditions (e.g., clear versus cloudy conditions).

Secondary Mission Capability

The secondary mission capability is provided when mission sensors other than the Imager and Profiler Suites are capable of delivering their RDRs to the C3S and IDPS, as required.

Second Year Ice

Sea ice, which has survived one summer's melt, with a thickness of 3 m or more. Most topographic features are smoother than on first-year ice.

Sensor

The mission-peculiar equipment or instrument to be manifested on a given space mission.

Sensor Data Records (SDRs)

Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geolocated, calibrated detected fluxes with associated ephemeris data. The existence of the SDRs provides an intermediate step between the EDRs and the raw data.

Sensor Suite

One or more sensors needed to satisfy the EDR requirements allocated to a given Sensor Requirements Document (SRD). It does not include sensors from other SRD suites which provide secondary data contributions to those EDRs.

Short-term Stability *(TBS)*

Short-wave Radiation

The solar radiation that is reflected back by the Earth and the atmosphere. It is generally in the spectral wavelength interval between 0.3 and 4 micrometers.

Significant Wave Height

The height of a theoretical wave whose height and period are equal to the average height and period of the largest one-third of the actual waves that pass a fixed point in some time period.

Soil Moisture

Moisture in the soil within the zone of aeration in cm/m (cm of water per meter of soil depth), including water vapor present in soil pores.

Spacecraft

The components and subsystems which support the sensor(s) and provide housekeeping functions such as orbit and attitude maintenance, navigation, power, command, telemetry and data handling, structure, rigidity, alignment, heater power, temperature measurements, etc.

Space Segment

The satellites (i.e., the spacecraft and their sensors) and their support equipment.

Specific Humidity

The mass of water vapor contained in a unit mass of air (dry air plus water vapor) expressed in grams per kilogram.

Spectral Index

Slope of the irregularity power spectrum of the electron energy density between two inverse scale lengths.

Stored Mission Data (SMD)

CADUs (frames) containing packets of science data packets from the instruments, and engineering, health, and safety packets from the Spacecraft and instruments.

Surface Albedo

The amount of visible solar radiation (0.4 - 0.7 μm) reflected by the earth's surface into a hemisphere divided by the amount incident. The major applications are twofold: 1) characterization of backgrounds by electro-optical systems; and 2) use in the visible cloud/no cloud decision for processed cloud data.

Swath-width

The area imaged perpendicular to the satellite track by a Synthetic Aperture Radar (SAR). Regional scale is defined by a 500 km swath, Littoral scale is defined by a 100 km swath and Local Scale is defined by a 50 km swath.

System Point Spread Function (PSF)

The end-to-end system response due to a point source at infinity in a given bandpass. In the SRD, the PSF is considered to be a function of distance along the ground in two orthogonal directions. (A point source on the ground is considered to be "at infinity.") The PSF is normalized so that the two dimensional integral over the two orthogonal distance variables is equal to one. For a linear system, the system PSF can be expressed as a multiple convolution of the PSFs associated with all system components that contribute to the conversion of input radiance to the system output, e.g., the optics, detectors, signal and data processing.

TACTERMs

Tactical field component terminals such as the AN/SMQ-11 and NITES or the FMQ-17 used by the USN and the METMF(R) used by the USMC; and the Mark IV, the Mark IVB, and the AN/TMQ-43 (Small Tactical Terminal) used by the AF

Target

A "target" value for a specified parameter is the maximum (minimum) of the range of preferred values for the parameter, where lower (higher) values of the parameter provide better performance or are otherwise more desirable. A design value falling between the target and goal values is desired by the government, and a value closer to the goal than the target is generally preferred, depending upon the impacts associated with approaching the goal. (See "goal".)

Telemetry

Health and status data of the satellite, including command authentication.

Temperature Data Records (TDRs)

Temperature Data Records (TDRs) are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from antenna temperature into counts.

TEMPEST

Short name referring to the investigation, study, and control of compromising emanations from telecommunications and automated information systems equipment.

Thick First- year Ice

First-year ice with a thickness of greater than 120 cm.

Thin first-year/white ice

First year ice 30-70 cm thick.

Threshold

A threshold performance requirement is considered the minimum, measurable capability or characteristic required to meet the users' need.

Tides

The periodic component of the sea surface topography induced by the gravitational interaction among the earth, moon, and sun.

Timeliness

Elapsed time between the initiation of the measurement(s) necessary to generate an estimate of an environmental data characteristic and delivery of the EDR containing the estimate to the user site.

Total Water Content

Total water content has two components: 1) Total columnar cloud liquid water content (CLWC), and 2) Total columnar integrated water vapor (TIWV).

Tropical Cyclone

The atmospheric phenomena characterized by a barotropic disturbance forming over tropical waters. The progression generally includes Tropical Depression, Tropical Storm and Hurricane/Typhoon/Cyclone.

Tropopause

The upper boundary of the troposphere, usually characterized by an abrupt change in lapse rate from positive (decreasing temperature with height) to neutral or negative (temperature constant or increasing with height).

Tropopause Height

The height of the tropopause, which is the upper boundary of the troposphere, where there is an abrupt change with respect to how the temperature changes with height, going from decreasing with height below the tropopause to increasing with height above the tropopause.

True Value

In simulations, the true values are known, by definition. When ground-truth data are used, estimates of the errors in the ground truth data will be factored into the comparisons between the ground-truth data and the EDRs to produce estimates of the measurement accuracy, precision, uncertainty, and long-term stability of the EDRs. The confirmation of meeting the measurement accuracy, precision, uncertainty, and long-term stability requirements for an EDR may be accomplished by analysis, laboratory measurements, simulations, and comparisons to direct or indirect observations, including observations taken from aircraft or spacecraft platforms. The confirmation method should include errors attributable to both the sensor and the processing algorithms.

Unique Support Equipment

Support equipment especially designed for use with a specific system and usable only on that system.

Users

The people, such as weather forecasters, who employ the obtained environmental data.

Vegetation Index

The identification of the predominant vegetation and/or soil type in a given area (see TRD Appendix D for details).

Vertical Cell Size

For a parameter which is an estimate of the uniform spatial average of an environmental parameter within a square layer of the atmosphere, the vertical thickness of this layer. (For a parameter which is an estimate of an environmental parameter at a point, the vertical cell size is defined to be zero.) (See the CrIS Unique SRD Para 3.2.1.1.1.1 for a CrIS-unique definition.)

Vertical Coverage

The specified vertical region of interest where data are to be collected or information is to be provided.

Vertical Reporting Interval

The spacing between nearest neighbor points along a local vertical at which an environmental parameter is estimated and reported. (This term is referred to as vertical sampling interval in the IORD; the terminology has been changed

to avoid misinterpretation as an sensor measurement sampling interval.) (See the CrIS Unique SRD Para 3.2.1.1.1.1 for a CrIS-unique definition.)

Visible Radiation

The radiation that the human eye senses as part of the process of "seeing." It is generally in the spectral wavelength interval between 0.4 and 0.7 micrometers. The blue end is near 0.4 micrometers and the red end is near 0.7 micrometers.

Visibility

The ability to detect objects through a layer of the atmosphere.

Wavelength Categories -- Visible/Infrared

	Visible	0.4 - 0.7 µm
NIR	Near Infrared	0.7 - 1.5 µm
SWIR	Short-wave Infrared	1.5 - 3 µm
MWIR	Medium Wave Infrared	3 - 5 µm
LWIR	Long Wave Infrared	5 - 50 µm

White Ice

See Thin first year ice.

APPENDIX B

SURVIVABILITY REQUIREMENTS

[Not applicable to NPP.]

Appendix B is classified and will be available in hardcopy in the NPOESS contractor libraries located in Silver Spring and Los Angeles after contract award.

APPENDIX C

NPOESS Baseline RF Requirements for C3 Links

30.1 Link Performance Characteristics

30.1.1 NPOESS Links - Common Characteristics

30.1.1.1 Availability

Link availability specifies the measures needed to compensate for rain and other atmospheric conditions. Link availability is independent from hardware and/or software reliability performance.

TRD30.1.1.1-1
The NPOESS shall be designed to have a minimum link availability on all uplinks and downlinks of at least 99.9% with the exception of the HRD downlink which is as specified in Table 3. [Not Applicable to NPP.]

TRD30.1.1.1-2
The NPP system shall be designed to have a minimum link availability on all uplinks from and downlinks to the ground station elements of at least 99%. Does not apply to NPP HRD link. [NPP only.]

TRD30.1.1.1-3
All Space Network (SN) crosslinks shall have a minimum link availability of 99.9% and comply with the RF link parameters specified in Tables 6 and 7.

30.1.1.2 Link Margin

TRD30.1.1.2-1
The NPOESS system shall maintain at least a +3 dB link margin for all links with the exception of the LRD link. [Not Applicable to NPP.]

TRD30.1.1.2-2
The NPOESS system shall maintain at least a (TBD) link margin for the LRD downlink at 5 degrees (TBR) elevation angle using a 1-meter ground aperture. [Not Applicable to NPP.]

TRD30.1.1.2-3
The NPP system shall maintain at least a +3 dB link margin for all links with the exception of the NPP HRD link. [NPP only]

TRD30.1.1.2-4
The NPP HRD link shall maintain at least a +1 dB link margin. [NPP only]

30.1.2 Uplinks

TRD30.1.2-1
DELETED

TRD30.1.2-2
DELETED

TRD 30.1.2-3
The NPP and NPOESS LEO&A and routine command uplink transmissions shall comply with the RF link parameters shown in Table 1 and/or Table 6, below.

TRD30.1.2-4
DELETED

30.1.3 Downlinks

TRD30.1.3-1
The LRD link shall comply with the RF link parameters shown in Table 2.

TRD30.1.3-2
The HRD link shall comply with the RF link parameters shown in Table 3.

TRD30.1.3-3
The NPP and NPOESS SMD Link shall comply with the RF link parameters shown in Table 4 and/or Table 7.

TRD30.1.3-5
NPP and NPOESS Satellites shall provide LEO&A real-time telemetry links as described in Table 5.

TRD30.1.3-6
Links defined in this Appendix shall be subject to PSD limitations in NTIA Redbook Section 8.2.36, Page 8-30, Revised 9/95.

Table 1 – Ground-to-Space Uplink Parameters

Link:	Parameter:	NPP Value:	NPOESS Value:
A: Routine Operations	Data Rate:	100 kbps (TBR)	128 kbps (TBR)
	Frequency (USB):	2106.4 MHz	2106.4 MHz
	Modulation:	BPSK	QPSK or O-QPSK (TBR)
	Coding:	(TBR) BCH (63, 56)	(255, 223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	N/A	 ½ (TBR) 7 bits (TBR) G1=111101/G2=1011011 (TBR) G1 assoc with first symbol (TBR) TBD NO
	Max. Occupied Bandwidth:	157 kHz (TBR)	173 kHz (TBR)
	E_b/N_o:	TBD	TBD
	BER (after decoding)	$< 10^{-8}$	$< 10^{-8}$
Inband @ X-Band:	Frequency:	N/A	8214.4 MHz (TBR)
	Ground Aperture Size:	N/A	13 meters (TBR)
	Ground EIRP:	N/A	46.0 dBm(TBR)
	Satellite Aperture Size:	N/A	TBD
	Satellite G/T:	N/A	TBD
B: LEO&A	Frequency (USB):	2106.4 MHz	2026.0 MHz, 2028.135 MHz
	Ground Aperture Size:	10,11 or 13 meters (TBR)	10,11 or 13 meters (TBR)
	Data Rate:	2kbps	2 kbps (TBR)
	Ground EIRP:	>66 dBW (TBR)	43.25 dBm (TBR)
	Modulation:	BPSK	QPSK or O-QPSK (TBR)
	Coding:	(TBR) BCH (63, 56)	(255, 223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	N/A	 ½ (TBR) 7 bits (TBR) G1=111101/G2=1011011(TBR) G1 assoc with first symbol (TBR) TBD NO
	Max. Occupied Bandwidth:	157 kHz (TBR)	173 kHz (TBR)
	E_b/N_o:	TBD	TBD
	BER (after decoding):	$< 10^{-8}$	$< 10^{-8}$
	Satellite Aperture Type:	"Omni"	"Omni"
	Satellite G/T:	N/A	TBD

Table 2 - LRD Downlink Parameters (N/A for NPP)

Parameter:	NPOESS Value:
Data Rate:	3.5 – 4.0 Mbps (TBR)
Modulation with bit interleaving:	QPSK or O-QPSK
Coding:	(255, 223) Reed Solomon with I=4
Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	 ½ (TBR) 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1 associated with first symbol (TBR) TBD No
Randomization	Yes
Maximum Occupied Bandwidth:	8.0 MHz
E_b/N_o:	TBD
BER after decoding	$< 10^{-8}$
L-Band Frequency:	1702 MHz - 1710 MHz (TBR)
Polarization	Right Hand Circular
Satellite EIRP	TBD
Minimum Elevation Angle	5 degrees (TBR)
Ground Aperture Size:	1.0 meters
Data Format (NRZ - _)	TBD
Ground G/T:	TBD @ 1 meter

Table 3 - HRD Downlink Parameters

Parameter:	NPP Value:	NPOESS Value:
Peak Data Rate:	15.0 Mbps Maximum	20.0 Mbps (TBR)
Modulation with bit interleaving:	QPSK	QPSK (TBR)
Coding:	(255, 223) Reed Solomon with I=4	(255, 223) Reed Solomon with I=4
Convolutional Encoding Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	 ½ 7 bits G1=1111001/G2=1011011 G1 associated with first symbol TBD No	 ½ 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1 associated with first symbol (TBR) TBD No
Randomization	$h(x)=x^8 + x^7 + x^5 + x^3 + 1$	TBD
Maximum Occupied Bandwidth:	TBD	30.8 MHz
E_b/N_o:	TBD	TBD
BER after decoding	$< 10^{-8}$	$< 10^{-8}$
X-Band Frequency:	7812 MHz	7812 MHz and 7830 MHz (TBR)
Polarization	Right Hand Circular	Right Hand Circular
Satellite EIRP	TBD	TBD
Minimum elevation angle	5.0 degrees (TBR)	5.0 degrees (TBR)
Ground Aperture Size:	3 meters (TBR)	$\leq$ 2 meters
Ground G/T at 5 degrees clear sky:	22.5 dB/K	17.2 dB/K (TBR)
Link Availability	N/A	99.9 % (97% with rain rate greater than 25 mm/hr.---"Panama Conditions")
Data Format	NRZ-M	NRZ-M (TBR)

Table 4 - Ground Station Element - SMD Downlink Parameters

Link:	Parameter:	NPP Value:	NPOESS Value:
SMD	Data Rate:	300.0 Mbps	400 Mbps Max (TBR)
	Modulation:	SQPSK	SQPSK (TBR)
	Coding:	(255, 223) Reed Solomon with I=4	(255,223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	N/A	 ½ (TBR) 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1 assoc with first symbol (TBR) TBD No
	Randomization	(Same as HRD)	(Same as HRD)
	Maximum Occupied Bandwidth:	375 MHz (TBR)	375 MHz
	E_b/N_o:	TBD	TBD
	BER after decoding	$< 10^{-8}$	$< 10^{-8}$
X-Band:	Frequency:	8212.5 MHz	8212.5 MHz
	Polarization	Right Hand Circular	Selectable Left/Right Hand Circular (TBR)
	Ground Aperture Size:	>= 11 meters (TBR)	13 meters (TBR)
	Ground G/T:	TBD	33.1 dB/K (TBR)
	Data Format:	NRZ-M	TBD
K_a-Band:	Frequency:	N/A	26250.0 MHz
	Maximum Occupied Bandwidth:	N/A	400 MHz (TBR)
	Polarization	N/A	Selectable Left/Right Hand Circular (TBR)
	Satellite Aperture Size:	N/A	TBD
	Satellite EIRP:	N/A	TBD
	Ground Aperture Size:	N/A	TBD
	Ground G/T:	N/A	TBD
	Data Format:	N/A	TBD

Table 5 - Ground Station Element - Telemetry Downlink Parameters

Link:	Parameter:	NPP Value:	NPOESS Value:
Telemetry Downlink:	Data Rate:	Simultaneously 512 kbps and either 1,4, or 16 kbps	10 kbps (TBR), TBD kbps
	Modulation:	SQPN	SQPN (TBR)
	Coding:	(255, 223) Reed Solomon with I=4	(255, 223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	 ½ 7 bits G1=1111001/G2=1011011 G1assoc with first symbol TBD No	 ½ (TBR) 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1assoc with first symbol (TBR) TBD No
	Randomization	(Same as HRD)	TBD (Same as HRD)
	Maximum Occupied Bandwidth:	TBD	198 kHz (TBR)
	E_b/N_o:	TBD	3.8 dB (TBR)
	BER after decoding	$< 10^{-8}$	$< 10^{-8}$
	Frequency (USB):	2287.5 MHz	2287.5 MHz, 2202.5 MHz
	Polarization	Right Hand Circular	Right Hand Circular
	Ground Aperture Size:	= 11m	TBD
	Ground G/T:	TBD	TBD
	Data Format:	NRZ-L	TBD

Table 6 – Space Network (SN)[1] Forward Link Parameters

Link:	Parameter:	NPP Value:	NPOESS Value:
a. LEO&A Only	Modulation:	UQPSK	UQPSK
	Coding:	BCH	BCH
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	N/A	 ½ (TBR) 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1assoc with first symbol (TBR) TBD No
	Randomization	TBD	TBD (Same as HRD)
	BER	$<10^{-5}$ Physical BER	$<10^{-5}$ Physical BER
	Polarization	Right Hand Circular	Right Hand Circular
Command Crosslink:	Data Rate:	125 bps; 1.0 kbps	125 bps, 1.0 kbps (TBR)
	Maximum Occupied Bandwidth:	2 kHz (TBR)	2 kHz (TBR)
	E_b/N_o:	TBD	TBD
TDRSS SA @ S-Band:	Frequency (USB):	2106.4 MHz	2106.4 MHz
	Satellite Aperture Size:	TBD	TBD
	TDRSS EIRP:	TBD	TBD
	Satellite G/T:	TBD	TBD
b. TDRSS SA @ K_u-Band:			
Calibration Table Upload Crosslink:	Data Rate:	N/A	256 kbps (TBR)
"Routine Commanding"	Occupied Bandwidth:	N/A	TBD
	E_b/N_o:	N/A	TBD
	Frequency:	N/A	13775 MHz
	Polarization	N/A	TBD
	TDRSS EIRP:	N/A	TBD
	Satellite G/T:	N/A	TBD

.

[1] Space Network Users Guide http://nmsp.gsfc.nasa.gov

Table 7- Space Network (SN) K_u-Band Return Link for SMD Parameters*

Link:	Parameter:	NPP Value:	NPOESS Value:
TDRSS SA K_u-Band: SMD	Data Rate:	100 – 150 (TBR) Mbps	150 Mbps (TBR)
	Modulation:	SQPSK	SQPSK
	Coding:	(255, 223) Reed Solomon with I=4	(255, 223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	 ½ 7 bits G1=1111001/G2=1011011 G1assoc with first symbol TBD No	 TBD TBD G1=TBD/G2=TBD TBD TBD TBD
	Randomization	TBD	TBD
	Maximum Occupied Bandwidth:	TBD	TBD
	E_b/N_o:	TBD	TBD
	BER	$< 10^{-5}$ Physical BER	$< 10^{-5}$ Physical BER
	Frequency:	15003.4 MHz	15003.4 MHz
	Satellite Aperture Size:	TBD	TBD
	Satellite EIRP:	TBD	TBD
	TDRSS Received Power:	TBD	TBD
	Polarization	Selectable Left/Right Hand Circular	Selectable Left/Right Hand Circular

* All values in SN Return Link determined by SN Users Guide except for SMD Data Rate

Table 8 – Space Network (SN) S-Band Return link Parameters

Link:	Parameter:	NPP Value:	NPOESS Value
TDRSS SA Telemetry Crosslink:	Data Rate:	1 kbps, 4 kbps; 16 kbps	2 kbps; 16 kbps (TBR)
	Modulation:	SQPN	SQPN
	Coding:	(255, 223) Reed Solomon with I=4	(255, 223) Reed Solomon with I=4 (TBR)
	Convolutional Encoding: Code Rate Constraint Length Connection Vectors Phase relationship Symbol inversion Puncturing	 ½ 7 bits G1=1111001/G2=1011 011 G1assoc with first symbol TBD No	 ½ (TBR) 7 bits (TBR) G1=1111001/G2=1011011 (TBR) G1assoc with first symbol (TBR) TBD No
	Randomization	TBS	TBD
	Maximum Occupied Bandwidth:	TBD	TBD
	E_b/N_o:	TBD	TBD
	BER	$< 10^{-5}$ Physical BER	$< 10^{-5}$ Physical BER
	Frequency (USB):	2287.5 MHz	2287.5 MHz
	Satellite Aperture Size	N/A	TBD
	Satellite EIRP:	TBD	TBD
	TDRSS Received Power:	TBD	TBD
	Polarization	Right Hand Circular	Right Hand Circular

APPENDIX D

ENVIRONMENTAL DATA RECORD CHARACTERISTICS

Note: Refresh rates do not apply for NPP

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RECORD OF CHANGES—Deleted

40.1 Conventions/General EDR Requirements

40.1.1 Requirements Format

EDR requirements are specified by a general definition of the required data content, the units for the reported data, and a set of attributes. These attributes fall into four categories: (1) those that further define data content in a precise, quantitative manner, (2) those that constrain the quality of the data to be provided, (3) those that constrain the reporting frequency for the EDR, and (4) the timeliness of EDR delivery to users. The attributes addressing data content are horizontal and vertical cell size, horizontal and vertical reporting interval, and horizontal and vertical coverage. The attributes addressing data quality are measurement uncertainty, measurement accuracy, measurement precision, long term stability, and mapping uncertainty. The primary attribute addressing reporting frequency is maximum local average revisit time. All of these attributes apply to data products, not to sensor performance characteristics, and are defined in the Glossary. The EDR requirements format is to address the data content attributes first, then the data quality attributes, and finally the reporting frequency attributes. The timeliness requirement is addressed as Latency within the tables.

General EDR requirements fall into two classes: (a) explicit requirements on the EDR content, quality, refresh, and timeliness, and (b) requirements to be derived by the contractor based on requirements for other EDRs. The explicit and application-related requirements are specified below.

TRD40.1.1-1
If a derived requirement conflicts with an explicit requirement and/or another derived requirement, the most stringent requirement shall be satisfied.

40.1.2 Key EDRs/Attributes

Attributes in bold type and marked with an asterisk are key attributes. A key EDR is one for which at least one attribute is key. Key EDRs are marked with an asterisk. Key attribute names and threshold values are also in bold font. Compliance with the TRD requires satisfaction of all EDR thresholds, whether the attribute or its EDR is key or not.

40.1.3 Attribute Values

Unless otherwise specified, attribute values are to be interpreted as upper bounds anywhere in the area where measurements are obtained, including the edge of the measuring sensor field of regard. A threshold or objective is "met" or "satisfied" if the system performance value is less than or equal to the specified value. As sensors are downselected, values from the appropriate specification documents will be identified as Thresholds. Attributes which are a function of the system will be designated with the following symbol (S).

40.1.4 Attribute Values Expressed as Percentages

Unless otherwise specified, a percentage appearing as a value for an attribute is to be interpreted as the percentage of the true value of the attribute. For any attribute where a percentage and a numerical value are specified, the greater of the two is the requirement.

40.1.5 Vertical Height

Vertical height is measured either by atmospheric pressure or by height above the earth's surface. A value of zero km for height refers to the earth's surface. Negative values of height refer to depth below the earth's surface (land or water).

40.1.6 Specification of Attributes at Nadir

Specification of horizontal cell size or horizontal spatial resolution at nadir does not imply that data must be acquired from a cross-track scanning sensor. The data may be acquired from a conically scanning sensor or any other sensor as long as the horizontal cell size or resolution along the satellite ground track does not exceed the nadir upper bound. For an EDR for which horizontal cell size is specified only at nadir, cell size is allowed to grow away from nadir as a normal function of the look angle.

40.1.7 Impact of Weather Conditions on EDR Requirements

The requirements for “clear” conditions are more stringent and apply when atmospheric conditions are such that infrared sensing (or any comparably capable technology) can be applied. The requirements for “cloudy” conditions are less stringent and apply when atmospheric conditions preclude the use of infrared sensing (or any comparably capable technology), but which can be met by microwave sensing (or any comparably capable technology). For guidance purposes, the government recommends that “clear” refer to less than 50 % cloud cover and “cloudy” refer to greater than or equal to 50 % cloud cover. Attributes designated as “all weather” imply cloudy conditions and rainfall rates less than 2 mm hr^{-1}.

TRD40.1.7-1
The contractor shall specify the conditions under which the requirement to deliver an EDR meeting data content and quality requirements will not be met, regardless of whether it is clear or cloudy.

TRD40.1.7-2
The contractor shall also specify the conditions under which it would recommend delivering an EDR which is incomplete and/or of degraded quality but which is still of potential utility to one or more users.

TRD40.1.7-3
Except for cloud EDRs and Space Environment EDRs, which must be met regardless of cloud cover, EDR requirements shall apply to clear conditions only unless otherwise specified.

40.1.8 Climate Products Long Term Stability

Climate Long Term Stability attributes, designated as “Long Term Stability (C)”, are not intended to drive stressing design changes on spacecraft sensors or require increased IDPS processing capabilities. These attributes require the contractor to characterize the precision and uncertainty bias of the sensor’s measurements and the impact on the resulting data products. There are many variables including spacecraft orbital drift, previous calibrations, age of sensors, etc. that affect the climate Long Term Stability. The intent is to be able to characterize the climate Long Term Stability and the associated bias in the measurements, not meet the absolute threshold value of the EDR attribute.

TRD40.1.8-1
The contractor shall maintain and deliver records of sensor calibration changes as well as other records required to characterize sensor biases and changes in bias over time.

TRD40.1.8-2
The bias of all EDRs (except SESS) shall be maintained for the entire NPOESS program. This requirement does not imply reprocessing, by NPOESS, of previously collected data for any observed bias changes.

TRD40.1.8-3
The bias data shall be characterized by each individual satellite sensor in a global manner and computed as a monthly and lifetime sensor value. This requirement does not imply reprocessing, by NPOESS, of previously collected data for any observed bias changes.

40.2 Key EDRs

40.2.1 *Atmospheric Vertical Moisture Profile (AVMP)

An atmospheric vertical moisture profile is a set of estimates of average mixing ratio in three-dimensional cells centered on specified points along a local vertical. The specification of this EDR is consistent with that for the CrIMSS; however, TBRs are included for quantification of any performance enhancements resulting from merging other sources (ex: CMIS) to create the IDPS AVMP EDR product. The mixing ratio of a sample of air is the ratio of the mass of water vapor in the sample to the mass of dry air in the sample.

Units: **g**/kg

Para. No.		Thresholds	Objectives
40.2.1-1	a. Horizontal Cell Size	14 km @ nadir	2 km @ nadir
40.2.1-2	b. Horizontal Reporting Interval	1 to 9 per FOR	2 km
40.2.1-3	c. Vertical Cell Size	2 km	2 km
	d. Vertical Reporting Interval		
40.2.1-4	1. Surface to 850 mb	20 mb	5 mb
40.2.1-5	2. 850 mb to 100 mb	50 mb	15 mb
40.2.1-6	e. Horizontal Coverage	Global	Global
40.2.1-7	f. Vertical Coverage	Surface to 100 mb	Surface to 100 mb
40.2.1-8	g. Measurement Range	0 - 30 g/kg	0 - 30 g/kg
	h. *Measurement Uncertainty (expressed as a percent of average mixing ratio in 2 km layers)		
	Clear		
40.2.1-9	**1. *Surface to 600 mb**	15%	10%
40.2.1-10	2. 600 mb to 300 mb	14%	10%
40.2.1-11	3. 300 mb to 100 mb	12%	10%
	Cloudy		
40.2.1-12	**4. *Surface to 600 mb**	16%	10%
40.2.1-13	5. 600 mb to 300 mb	18%	10%
40.2.1-14	6. 300 mb to 100 mb	17%	10%
40.2.1-15	i. Mapping Uncertainty	5 km	1 km
40.2.1-16	j. Maximum Local Average Revisit Time	8 hrs	3 hrs
40.2.1-17	k. Deleted.		
40.2.1-18	l. Latency (S)	156 min	15 minutes
40.2.1-19	m. Long-term Stability (C) (CrIS/ATMS)	2%	1%

**. Paragraph 40.2.1-16 is satisfied by using the 0530 CMIS in addition to the CrIMSS.

40.2.2 *Atmospheric Vertical Temperature Profile (AVTP)

An atmospheric temperature profile is a set of estimates of the average atmospheric temperature in three-dimensional cells centered on specified points along a local vertical. The specification of this EDR is consistent with that for the CrIMSS; however, TBRs are included for quantification of any performance enhancements resulting from merging other sources (ex: CMIS) to create the IDPS AVTP EDR product.

Units: K

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
40.2.2-1	1. Clear, nadir	14 km Surface to 0.5 mb 200 km 0.5 to 0.01mb	1 km
40.2.2-2	2. Clear, worst case	50 km	(TBD)
40.2.2-3	3. Cloudy, nadir	40 km	1 km
40.2.2-4	4. Cloudy, worst case	200km	(TBD)
40.2.2-5	b. Horizontal Reporting Interval	One to nine per FOR	(TBD)
	c. Vertical Cell Size		
	Clear		
40.2.2-6	1. Surface to 300 mb	1 km	(TBD)
40.2.2-7	2. 300 mb to 30 mb	3 km	(TBD)
40.2.2-8	3. 30 mb to 1 mb	5 km	(TBD)
40.2.2-9	4. 1 mb to 0.5 mb	5 km	(TBD)
40.2.2-40	5. 0.5 to 0.01 mb	5 km	(TBD)
	Cloudy		
40.2.2-10	6. Surface to 700 mb	1 km	(TBD)
40.2.2-11	7. 700 mb to 300 mb	1 km	(TBD)
40.2.2-12	8. 300 mb to 30 mb	3 km	(TBD)
40.2.2-13	9. 30 mb to 1 mb	5 km	(TBD)
40.2.2-14	10. 1 mb to 0.5 mb	5 km	(TBD)
40.2.2-41	11. 0.5 to 0.01 mb	5 km	(TBD)
	d. Vertical Reporting Interval		
40.2.2-15	1. Surface to 850 mb	20 mb	10 mb
40.2.2-16	2. 850 mb to 300 mb	50 mb	10 mb
40.2.2-17	3. 300 mb to 100 mb	25 mb	15 mb
40.2.2-18	4. 100 mb to 10 mb	20 mb	10 mb
40.2.2-19	5. 10 mb to 1 mb	2 mb	1 mb
40.2.2-20	6. 1 mb to 0.1 mb	0.2 mb [1 mb to .5 mb]	0.1 mb
40.2.2-21	7. 0.1 mb to 0.01 mb	0.02 mb	0.01 mb
40.2.2-22	e. Horizontal Coverage	Global	Global
40.2.2-23	f. Vertical Coverage	Surface to 0.01 mb	Surface to 0.01 mb
40.2.2-24	g. Measurement Range	180-335K [Earth Scene] 180-310K [Black Body]	162-335 K (TBR)
40.2.2-25	Not Used		
	h. Measurement Uncertainty		
	Clear		
40.2.2-26	1. *Surface to 300 mb	0.9 K/1 km layer	0.5 K/1 km
40.2.2-27	2. 300 mb to 30 mb	0.98 K/3 km layers	0.5 K/1 km

40.2.2-28	3. 30 mb to 1 mb	1.45 K/5 km layers	0.5 K/1 km
40.2.2-29	4. 1 mb to 0.3 mb	3.5 K /5 km layers	0.5 K/1 km
40.2.2-42	5. 0.3 to 0.01 mb	6.5 K/5 km layer	0.5 K/1 km
	Cloudy		
40.2.2-30	6. *Surface to 700 mb	2.0 K/ 1 km layer	0.5 K/1 km
40.2.2-31	7. 700 mb to 300 mb	1.4 K/ 1 km layer	0.5 K/1 km
40.2.2-32	8. 300 mb to 30 mb	1.3 K/ 3 km layer	0.5 K/1 km
40.2.2-33	9. 30 mb to 1 mb	1.45 K/ 5 km layer	0.5 K/1 km
40.2.2-34	10. 1 mb to 0.0.5 mb	3.5 K / 5 km layer	0.5 K/1 km
40.2.2-43	11. 0.5 to 0.01 mb	6.5 K/ 5 km layer	0.5 K/1 km
40.2.2-35	i. Mapping Uncertainty	5 km	1 km
40.2.2-36	j. Maximum Local Average Revisit Time	6 hrs (TBR)	3 hrs
40.2.2-37	k. Deleted.		
40.2.2-38	l. Latency (S)	156 min	15 minutes
40.2.2-39	m. Long Term Stability (C) (CrIS/ATMS)	Trop Mean 0.05 K Strat Mean 0.1 K	Trop 0.03 K Strat 0.05 K

40.2.3 *Imagery

Imagery requirements fall into three classes: (a) explicit requirements on the EDR content, quality, reporting frequency, and timeliness, (b) requirements to be derived based on specific applications utilizing the imagery EDR, such as manual generation of cloud and sea ice data, and (c) requirements to be derived by the contractor based on requirements for other EDRs supported by the imagery. The explicit and application-related requirements are specified below. (Automated generation of cloud data is addressed in other EDRs and therefore will not be addressed below.)

40.2.3.1 Explicit EDR Requirements

Imagery is defined as the measured locally-averaged upwelling radiance or equivalent black body temperature from the earth's surface and atmosphere in one or more spectral bands, where the local averages are reported for the points of a two-dimensional approximately rectangular lattice. (The lattice is only approximately rectangular primarily because of the steep scan angle near the edge-of-scan and increased range to scene compared to nadir.) The form of the weighting function that determines the local average is constrained by the horizontal spatial resolution requirement. The number of spectral bands, band limit values, measurement ranges, and measurement uncertainty requirements are to be derived based on the application-related requirements given below and on the requirements of other EDRs supported by the imagery. However, at least one daytime visible, one nighttime visible, and at least one IR channel are required. Daytime and nighttime visible imagery must be merged so as to minimize the apparent transition across the terminator. The requirements for all weather conditions are less stringent and apply when atmospheric conditions preclude the use of infrared sensing, but which can be met by microwave (or any comparable technology) sensing. Unless otherwise specified, the explicit EDR requirements below apply to each spectral band that is required for the Application-Related requirements of section 40.2.3.2 and at a minimum, to at least one daytime visible, one nighttime visible, and one IR channel (TBR). Except for attributes designated as "all weather," the explicit horizontal spatial resolution and mapping uncertainty requirements specified below do not apply to microwave imagery.

TRD40.2.3.1-1
Brightness temperatures from each microwave channel and polarization, if applicable, shall be available for display at the sampled resolution.

Para. No.		Threshold	Objectives
	a. ***Horizontal Spatial Resolution (HSR)**		
40.2.3.1-2	Deleted		
40.2.3.1-3	Deleted		
40.2.3.1-4	1. Nadir	0.4 km	0.1 km
40.2.3.1-5	2 Worst case	0.8 km	0.1 km
40.2.3.1-6	3. Nighttime Visible, worst case	0.74 km	0.65 km
40.2.3.1-18	4. All Weather	40 km	20 km
40.2.3.1-7	b. Horizontal Reporting Interval	Imagery HSR	Derived (gapless or near gapless coverage)
40.2.3.1 -8	c. Horizontal Coverage	Global	Global
40.2.3.1-9	Deleted		
	d. Measurement Range		
40.2.3.1-10	1. Nighttime visible	4.00E-09 to 3.00E-02 W/(cm^2sr)	Includes threshold range
40.2.3.1-11	2. Other bands	0.640 band: 5.0 to 718 W/(m^2 sr μm) 3.7 band: 210 K to 353 K 11.45 band: 190 K to 340 K	Derived
40.2.3.1-12	e. Measurement Uncertainty	Derived	Derived
	f. Mapping Uncertainty		

40.2.3.1-13	1. At nadir	0.4 km	0.4 km
40.2.3.1-14	2. Worst case	1.5 km	0.5 km
40.2.3.1-19	3. All Weather	3 km	
40.2.3.1-15	g. *Maximum Local Average Revisit Time	4 hrs	(TBD)
40.2.3.1-16	h. *Maximum Local Refresh	6 hrs	(TBD)
40.2.3.1-17	i. *Fraction of Revisit Times Less Than a Specified Value	At any location at least 75 % of the revisit times will be 4 hours or less	(TBD)
40.2.3.1-20	j. Latency (S)	90 minutes	15 minutes

40.2.3.2 Application-Related Requirements

TRD 40.2.3.2-1
The content, quality, and reporting frequency of the imagery shall suffice to support the following application-related requirements. These requirements, together with requirements of other EDRs supported by the imagery, determine the derived requirements in the explicit EDR requirement set above and may drive specified values of non-derived attributes to more stringent values. The content of the application-related data products is not part of the content of the imagery EDR. It is assumed that flowdown of application-related requirements to explicit imagery requirements will be performed by contractor simulation and modeling.

40.2.3.2.1 Manually Generated Cloud Data

Manually generated cloud data are estimates of cloud cover and cloud type generated by a human analyst viewing the unprocessed and/or processed imagery derived from the unprocessed imagery, e.g., by data fusion, spatial rescaling, image enhancement, etc.

40.2.3.2.1.1 Cloud Cover

Cloud cover is defined as the fraction of a given area, i.e., of a horizontal cell, on the Earth's surface for which a locally normal line segment extending between two given altitudes, intersects a detectable cloud as defined in the Glossary. For manual analyses, cloud cover is estimated for a single atmospheric layer. Specifically, the minimum and maximum altitudes of this layer are defined to be the surface of the Earth and the altitude where the pressure is 0.1 mb. Haze, smoke, dust, and rain are not to be considered clouds. For the purpose of validating this requirement, cloud cover estimates are to be generated by a trained human analyst viewing unprocessed and/or processed imagery for contiguous square areas having side length equal to the horizontal cell size specified below.

Units: Dimensionless

Para. No.		Threshold	Objectives
40.2.3.2.1.1-6	a. Horizontal Cell Size	3 times HSR (1.2 km at nadir)	2 times the Imagery HSR
40.2.3.2.1.1-1	Deleted		
40.2.3.2.1.1-2	Deleted		
40.2.3.2.1.1-3	b. Horizontal Reporting Interval	Horizontal cell size	Horizontal cell size
40.2.3.2.1.1-4	c. Measurement Range	0 – 1, 0.1 increments	0 – 1, 0.1 increments
40.2.3.2.1.1-5	d. Measurement Uncertainty	0.1	0.1

40.2.3.2.1.2 Cloud Type

Cloud types are defined as follows:

(1) Altocumulus (AC) (2) Altocumulus Castellanus (ACCAS) (3) Altocumulus (standing lenticular) (ACSL) (4) Altostratus (AS) (5) Cirrocumulus (CC) (6) Cirrocumulus (standing lenticular) (CCSL) (7) Cirrostratus (CS) (8) Cirrus (CI) (9) Cumulonimbus (CB) (10) Cumulus (CU) (11) Cumulus Fractus (CUFRA) (12) Towering Cumulus (TCU) (13) Stratus Fractus (STFRA) (14) Nimbostratus (NS) (15) Stratocumulus (SC) (16) Stratocumulus (Standing lenticular) (SCSL) (17) Stratus (ST)

CLOUD TYPING NOT ONLY ENTAILS A CAPABILITY TO DISTINGUISH BETWEEN CLOUDS OF DIFFERENT TYPES, BUT ALSO A CAPABILITY TO DISTINGUISH CLOUDS FROM OTHER FEATURES, SUCH AS SNOW, COLD WATER, COLD LAND, HAZE, SMOKE, DUST, ETC. THEREFORE, THE FOLLOWING ADDITIONAL TYPES ARE DEFINED: (18) OBSCURED/NOT CLOUDY (19) CLEAR.

A given area is classified as "obscured/not cloudy" if there are no detectable clouds within the atmosphere overlying the area and if the average vertical LOS extinction optical thickness of the atmosphere overlying the area is > 0.03 (TBR) 0.645 μm region. A given area is classified as "clear" if there are no detectable clouds, as defined above, overlying the area and if the average vertical LOS extinction optical thickness of the atmosphere overlying the area

is < 0.03 in the 0.645 μm region. Note that other EDRs require the type of non-cloud obscuration to be discerned and identified, e.g., smoke, dust, sand, ash, etc.

For the purpose of validating this requirement, typing is performed by a trained human analyst viewing unprocessed and/or processed imagery for contiguous square areas having side length equal to the horizontal cell size specified below. The probability of correct typing is defined as the probability that a cell reported as being of type x is in fact of type x, where x is any of the types specified above.

Units: N/A

Para. No.		Threshold	Objectives
40.2.3.2.1.2-7	a. Horizontal Cell Size	3 times HSR (1.2 km at nadir)	(TBD) times Imagery HSR
40.2.3.2.1.2-1	Deleted		
40.2.3.2.1.2-2	Deleted		
40.2.3.2.1.2-3	b. Horizontal Reporting Interval	Horizontal cell size	Horizontal cell size
40.2.3.2.1.2-4	c. Measurement Range	14 cloud types **	Clear, obscured/not cloudy, all 17 cloud types
40.2.3.2.1.2-8	d. Probability of Correct Typing	85%	90% at (TBS) % confidence level
40.2.3.2.1.2-5	Deleted		
40.2.3.2.1.2-6	Deleted		

** Altocumulus (AC); Altostratus (AS); Cirrocumulus (CC); Cirrocumulus (standing lenticular) (CCSL); Cirrostratus (CS); Cirrus (CI); Cumulonimbus (CB); Cumulus (CU); Towering Cumulus (TCU) ; Stratocumulus (SC); Stratocumulus (standing lenticular) (SCSL); Stratus (ST); Obscured/not cloudy; Clear.

40.2.3.2.2 Sea Ice Data

Sea ice data may be generated interactively by a human analyst viewing unprocessed or processed imagery at a computer workstation, or automatically via an algorithm. In addition to determination of ice edge location and ice concentration as described below, analysts will attempt to determine the thickness and size of leads and polynyas based on the imagery.

40.2.3.2.2.1 Ice Edge Location

An ice edge is defined as the boundary between ice-covered sea water (ice concentration > 0.1) and sea water not covered by ice (ice concentration $\leq$ 0.1). Ice concentration is defined as the fraction of a given area sea or water covered by ice. An ice edge is typically provided as a contour on a map or in digital form as a set of latitude/longitude coordinates. The ice edge location error is defined as the distance between the estimated location of an ice edge and the nearest location of a true ice edge.

Units: Degrees latitude and longitude

Para. No		Threshold	Objectives
40.2.3.2.2.1-1	a. Horizontal Coverage	North of 36 deg north latitude, south of 50 deg south latitude for sea ice	North of 36 deg north latitude, south of 50 deg south latitude for sea ice
40.2.3.2.2.1-2	b. Measurement Range	Any latitude, longitude in degrees within horizontal coverage	Any latitude, longitude within coverage domain
	c. Measurement Uncertainty		
40.2.3.2.2.1-3	1. Clear	0.4 at nadir 1.0 km worst case	(TBD)
40.2.3.2.2.1-4	2. Cloudy	(TBD)	(TBD)
40.2.3.2.2.1-5	3. Deleted		
40.2.3.2.2.1-6	4. Deleted		

40.2.3.2.2.2 Ice Concentration

Ice concentration is defined as the fraction of a given area of sea water covered by ice. It is typically derived from imagery and reported on ocean geographical charts for areas between contours generated by an analyst.

Units: Dimensionless

Para. No.		Threshold	Objectives
40.2.3.2.2.2-1	a. Horizontal Coverage	North of 36 deg north latitude, south of 50 deg south latitude for sea ice	North of 36 deg north latitude, south of 50 deg south latitude for sea ice
40.2.3.2.2.2-2	b. Measurement Range	0 – 1 HCS Area , 0.1 increments	0 – 1, 0.1 increments
40.2.3.2.2.2-3	c. Measurement Uncertainty	0.1	0.1

40.2.4 *Sea Surface Temperature (SST)

Sea surface temperature (SST) is defined as a highly precise measurement of the temperature of the surface layer (skin) and upper 1 meter (bulk) of ocean water. It has two major applications: (1) sea surface phenomenology, and (2) use in infrared cloud/no cloud decisions for processed cloud data. The requirements below apply only under clear conditions unless otherwise stated.

Units: K

Para. No.		Threshold	Objectives
	a. *Horizontal Cell Size		
40.2.4.1	Deleted		
40.2.4.2	Deleted		
40.2.4-3	1. *Nadir	0.8 km	0.25 km
40.2.4-4	2. Worst case, clear	1.3 km	(TBD)
40.2.4 –18	3. All Weather	40 km	20 km
40.2.4-24			
40.2.4-5	b. Horizontal Reporting Interval	HCS	(TBD)
40.2.4-23	c. Horizontal Coverage	Oceans	Oceans
40.2.4.6	Deleted		
40.2.4.7	Deleted		
40.2.4-8	d. Measurement Range	271 K – 313 K	271 K – 313 K
	e. Measurement Uncertainty (skin)		
40.2.4 – 9	1. * Clear	0.5 K	0.1 K
40.2.4 – 20	2. All Weather	0.5 K	0.5 K
40.2.4-25	3. Deleted		
40.2.4-10	f. Measurement Uncertainty (bulk)	0.5 K	0.1 K
	g. Measurement Precision (skin)		
40.2.4 –11	1. Clear	0.27 K	0.1 K
40.2.4-19	2. All Weather	0.5 K	0.1 K
40.2.4-26	3. Deleted		
	h. Mapping Uncertainty		
40.2.4-12	1. Nadir	0.4 km	0.1 km
40.2.4-13	2. Worst case, clear	0.8 km	(TBD)
40.2.4-14	3. All Weather	3 km	3 km
40.2.4-27	4. Deleted		
40.2.4-15	Deleted		
40.2.4-16	i. Maximum Local Average Revisit Time	6 hrs	3 hrs
40.2.4-17	j. Measurement Precision (bulk, clear).	0.27 K	0.1 K
40.2.4-21	k. Long Term Stability (C)	0.1 K	0.05 K
40.2.4-22	l. Latency (S)	90 minutes	15 minutes

40.2.5 *Sea Surface Winds (Speed and Direction)

Measure of atmospheric wind speed and direction at the sea/atmosphere interface (10 meter height neutral stability winds) in clear sky and cloudy conditions, for integrated rainfall rates less than 2 mm hr^{-1}.

Units:
Speed, m/s
Direction, degrees from geographic (true) north

Para. No.		Thresholds	Objectives
40.2.5-1	a. Horizontal Cell Size	20 km	1 km
40.2.5-2	b. Horizontal Reporting Interval	20 km	1 km
40.2.5-3	c. Horizontal Coverage	Ice-free Oceans	Oceans
	d. Measurement Range		
40.2.5-4	1. Speed	3 – 25 m/s	1 – 50 m/s
40.2.5-5	2. Direction	0 – 360 deg	0 – 360 deg
	e. *Measurement Accuracy		
40.2.5-6	1. *Speed	1 m/s or 10 % of true value, whichever is greater	1 m/s or 10 % of true value, whichever is greater
40.2.5-7	2. Direction (HCS is 56X35 km cell)	20 deg for wind speeds greater than 5 m/s 25 deg for wind speeds 3 – 5 m/s	10 deg
	f. Measurement Uncertainty		
40.2.5-8	1. Speed		
40.2.5-15	a. 3-18 m/s	2 m/s	Greater of 1 m/s or 10%
40.2.5-16	b. 18-25 m/s	2.5 m/s	Greater of 1 m/s or 10%
40.2.5-9	2. Direction (HCS is 56X35 km cell)**	20 deg for wind speeds greater than 5 m/s 25 deg for wind speeds 3 - 5 m/s	10 deg
40.2.5-10	g. Mapping Uncertainty	3 km	1 km
40.2.5-11	h. Maximum Local Average Revisit Time	6 hrs	1 hrs
40.2.5-12	i. Deleted		
40.2.5-13	j. Long Term Stability (C)	0.5 m sec^{-1} $decade^{-1}$	(TBD)
40.2.5-14	k. Latency (S)	90 minutes	15 MINUTES

** Direction uncertainty to be applied to the unique chosen ambiguity.

40.2.6 *Soil Moisture

Total water in all phases in the soil or in a surface layer over soil. The threshold requirement is to measure soil moisture only within a thin layer at the surface (0.1 cm thick) and only for bare soil in regions with known soil types. The objective is to measure a moisture profile for any soil, whether bare or not, and whether or not the soil type is known.

Units: cm/m (cm of water per meter of soil depth)

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.2.6-1	1. Clear daytime, at nadir	0.75 km	(TBD)
40.2.6-2	2. Clear daytime, worst case	1.6 km	1.6 km
40.2.6-3	3. All weather, at nadir	40 km	2 km
40.2.6-4	4. All weather, worst case	50 km	(TBD)
40.2.6-5	b. Horizontal Reporting Interval	HCS	(TBD)
40.2.6-6	c. Vertical Cell Size	0.1 cm	5 cm
40.2.6-7	d. Vertical Reporting Interval		
40.2.6-8	e. Horizontal Coverage	Land	Land
40.2.6-9	f. *Vertical Coverage	Surface to –0.1 cm (SKIN LAYER)	Surface to -80 cm
40.2.6-10	g. Measurement Range	0 - 100 cm/m	0 - 100 cm/m
	h. Measurement Uncertainty		
40.2.6-11	1. Clear, Bare soil in regions with known soil types (smaller horizontal cell size)	Surface: 5 cm/m up to field capacity, 10 cm/m beyond capacity	Surface: 1% 80 cm column: ±5 %
40.2.6-12	2. Cloudy , Bare soil in regions with known soil types (greater horizontal cell size)	20 cm/m	Surface: 1 cm/m Total 80 cm column: 5 %
40.2.6-13	i. Mapping Uncertainty	1.5 km	1 km
40.2.6-14	j. Maximum Local Average Revisit Time	8 hrs	3 hrs
40.2.6-15	k. Deleted		
40.2.6-16	l. Latency (S)	90 minutes	30 minutes

40.3 Atmospheric EDRs

40.3.1 Aerosols

Aerosols are defined as suspensions of liquid droplets or solid particles in the atmosphere. Aerosols include, but are not limited to, smoke, dust, sand, volcanic ash, sea spray, polar stratospheric clouds, and smog. Water and ice clouds are also aerosols, but because of the frequency of their occurrence and their importance to military operations, they are addressed separately in another EDR (See Sec. 40.2.3, Imagery).

40.3.1.1 Aerosol Optical Thickness

Aerosol optical thickness (AOT), for this EDR, is defined as the extinction (scattering + absorption) vertical optical thickness of modes 1 (~0.1 μm) and 2 (1.0 μm) of the bimodal aerosol size distribution at multiple wavelengths within the 0.4 - 2.4 micron spectral range (# applies to total column optical depth). Attributes designated as "Climate" require a polarimeter in addition to a high-resolution imager to attain threshold values. Optical thickness (τ) is related to transmission (t) by $t = \exp(-\tau)$. The refresh requirement for the climate products is to provide observations from the satellite nadir-track of any satellite carrying the aerosol polarimeter. The requirements below apply only under clear and daytime conditions.

Units: Dimensionless

Para. No.		Threshold	Objectives
40.3.1.1-1	a. Horizontal Cell Size	1.6 km over ocean; 9.6 km over land	1 km
40.3.1.1-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.3.1.1-3	c. Vertical Cell Size	Total Column	50 km
40.3.1.1-4	1. [0 – 2 km]	N/A	0.25 km
40.3.1.1-5	2. [2 – 5 km]	N/A	0.5 km
40.3.1.1-6	3. [> 5 km]	N/A	1 km
40.3.1.1-7	d. Vertical Reporting Interval	Vertical cell size	Vertical cell size
40.3.1.1-8	e. Horizontal Coverage	Global	Global
40.3.1.1-9	f. Vertical Coverage	0 – 50 km	0 – 50 km
	g. Measurement Range		
40.3.1.1-10	1. Operational	0.0 to 2.0 units of τ	0-10
40.3.1.1-18	2. Climate	0.0 to 5.0 units of τ	0-10
	h. Measurement Accuracy		
40.3.1.1-11	1. Operational, Over Ocean	$\tau < 0.5$ -- 0.02 $\tau \geq 0.5$ -- 0.07τ - 0.015	0.01
40.3.1.1-19	2. Climate, Over Ocean	Greater of 0.02 or 7%	Greater of .01 or 5%
40.3.1.1-12	3. Operational, Over Land	$\tau < 1$ -- 0.1 $\tau \geq 1$ -- 0.15	0.1
40.3.1.1-20	4. Climate, Over Land	Greater of 0.04 or 10%	Greater of 0.03 or 7%
	i. Measurement Precision		
40.3.1.1-13	1. Operational	Over ocean $\tau \leq 0.6$ -- 0.02 $\tau > 0.6$ --0.03 Over land – 0.1	0.01
40.3.1.1-21	2. Climate, Over Ocean	0.01	0.005
40.3.1.1-22	3. Climate, Over Land	0.03	0.02
40.3.1.1-14	j. Long Term Stability	0.01	0.003
40.3.1.1-15	k. Mapping Uncertainty	1.5 km	1 km
	l. Maximum Local Average Revisit Time		
40.3.1.1-16	1. Operational (S)	6 hrs	4 hrs
40.3.1.1-23	2. Climate	N/A	N/A
40.3.1.1-17	m. Deleted.		
40.3.1.1-24	n. Measurement Uncertainty,	$\tau < 0.45$ $0.05+0.2\tau$	

	Operational, over land	$0.45 < \tau \leq 1$ 0.14 $\tau > 1$ 0.18	

40.3.1.2 Aerosol Particle Size Parameter

Aerosol particle size may be characterized by two different parameters, the Ångström wavelength exponent and the effective radius. The Ångström wavelength exponent "alpha" (α) is defined by:

$$\alpha = - \Delta \ln \tau / \Delta \ln \lambda$$

where: "tau" (τ) is the extinction (scattering + absorption) vertical optical thickness of the aerosols within specified layers of the atmosphere, "lambda" (λ) is the wavelength, and "delta" (Δ) refers to the difference between measurements in two narrow bands. The effective radius is the area weighted average radius of the aerosol particle size distribution or, equivalently, the ratio of the third to the second moments of the size distribution. The threshold requirement is to measure the Ångström wavelength exponent based on two different narrow wavelength bands (bandwidth ≤ 0.05 μm) within the 0.4 to 1.0 micron spectral range for which the midpoint wavelengths are separated by at least 0.2 μm, and meet the data content and quality requirements pertaining to this parameter in the threshold column of the table below. The objective is to measure the effective radius of the aerosol particle size distribution and meet the data content and quality objectives pertaining to this parameter given in the table below.
For the climate applications, the size denotes a measurement of the bimodal size distribution of the aerosol population in terms of the effective radius r_e and effective variance ν_e of each mode. The effective radius is the ratio of the third moment of the aerosol size distribution to the second moment. The effective variance characterizes the width of the size distribution. Attributes designated as "Climate" require a polarimeter in addition to a high-resolution imager to attain threshold values. The refresh requirement for the climate products is to provide observations from the satellite nadir-track of any satellite carrying the aerosol polarimeter. The requirements below apply only under clear and daytime conditions. ($\notin$ - applies only to sub-satellite pixels.)

Units: Ångström Wavelength Exponent: Dimensionless.
Effective Radius: μm

Para. No.		Threshold	Objectives (Pertaining to effective radius)
40.3.1.2-1	a. Horizontal Cell Size	1.6 km over ocean 9.6 km over land	1 km
40.3.1.2-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.3.1.2-3	c. Vertical Cell Size	Total column	50 km
40.3.1.2-4	1. [0 - 2 km]	N/A	0.25 km
40.3.1.2-5	2. [2 - 5 km]	N/A	0.5 km
40.3.1.2-6	3. [> 5 km]	N/A	1 km
40.3.1.2-7	d. Vertical Reporting Interval	N/A	Vertical cell size
40.3.1.2-8	e. Horizontal Coverage	Global	Global
40.3.1.2-9	f. Vertical Coverage	0 – 30 km	0 - 50 km
	g. Measurement Range		
40.3.1.2-10	1. Operational	-1 to +3 units of α	0.05 to 5 μm
40.3.1.2-17	2. Climate	0 to 5 μm or 10% for r_e 0 to 3 for ν_e	0 to 10 μm or 10% for r_e 0 to 5 for ν_e
	h. Measurement Accuracy		
40.3.1.2-11	1. Operational	Ocean $\tau < 0.04$ -- 0.3 Ocean $\tau \geq 0.04$ – 0.1 Land 0.6	10 %
40.3.1.2-19	2. Climate	Greater of 0.1μm or 10% for r_e Greater of 0.3 or 50% for ν_e $^{\notin}$	Greater of 0.05 μm or 5% for r_e Greater OF 0.2 OR 30% for ν_E
	i. Measurement Precision		
40.3.1.2-12	1. Operational	Ocean $\tau < 0.04$ -- 0.3 Ocean $\tau \geq 0.04$ – 0.1 Land 0.6	10%
40.3.1.2-18	2. Climate	Greater of 0.05μm or 10% for r_e	Greater of 0.05 μm or 5% for r_e

		Greater of 0.1 or 40% for ν_e [≠]	Greater of 0.1 or 20% for ν_e
40.3.1.2-13	j. Long Term Stability (C)	Greater of 0.05μm or 10% for r_e Greater of 0.2 or 40 % for ν_e [≠]	Greater of 0.05 μm or 5% for r_e Greater of 0.1 or 20 % for ν_e
40.3.1.2-14	k. Mapping Uncertainty	1.5 km	1 km
	l. Maximum Local Average Revisit Time (S)		
40.3.1.2-15	1. Operational	6 hrs	4 hrs
40.3.1.2-20	2. Climate	N/A	N/A
40.3.1.2-16	m. Deleted.		

40.3.1.3 Suspended Matter

As a threshold, the required content of this EDR is to report the presence of suspended matter such as dust, sand, volcanic ash, SO_2, or smoke at any altitude. The objective is to report the presence of suspended matter in 0.2 km thick layers of the atmosphere, including sea salt and radioactive material. Other objectives are discriminating and classifying different types of suspended matter, for clearly delineated types, and reporting the concentrations of suspended matter types. Minimum detectable concentration levels for suspended matter types are not specified, and will be a by-product of capabilities required by other EDRs. The requirements below apply only under clear, daytime conditions.

Units:
Typing: N/A
Concentration: $\mu g/m^3$

Para. No.		Threshold	Objectives
40.3.1.3-1	a. Horizontal Cell Size	1.6 km	1 km
40.3.1.3-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.3.1.3-3	c. Vertical Cell Size	Total Column	0.2 km
40.3.1.3-4	d. Vertical Reporting Interval	N/A	Vertical Cell Size
40.3.1.3-5	e. Horizontal Coverage	Global	Global
40.3.1.3-6	f. Vertical Coverage	0-30 km	(TBD)
	g. Measurement Range		
40.3.1.3-14	1. Detection	Flag cells where atmosphere contains suspended matter	Flag atmospheric layers containing suspended matter
40.3.1.3-7	2. Type	Dust, sand, volcanic ash, sea salt, smoke, SO_2	Dust, sand, volcanic ash, sea salt, smoke, SO_2, radioactive material, other
40.3.1.3-8	3. Concentration	0 - 1000 $\mu g/m^3$ for smoke	0 - 100 $\mu g/m^3$ for smoke, other types (TBD)
40.3.1.3-9	h. Probability of Correct Typing	Suspended matter 90% Dust/sand 85% Smoke 85% Volcanic Ash 85% Sea Salt 85% SO_2 85%	(TBD) for classes
40.3.1.3-10	i. Measurement Uncertainty (concentration)	Smoke 50%	(TBD)
40.3.1.3-11	j. Mapping Uncertainty	1.5 km	0.1 km
40.3.1.3-12	k. Maximum Local Average Revisit Time (S)	12 hrs	3 hrs
40.3.1.3-13	l. Deleted.		
40.3.1.3-15	m. Latency (S)	90 minutes	15 minutes

40.3.1.4 Aerosol Refractive Index, Single-Scattering Albedo, and Shape

Measurement of the real part of the refractive index *m* and the single-scattering albedo ϖ of each mode of the bimodal aerosol size distribution at multiple wavelengths within the 0.4 – 2.4 micron spectral range and determination whether aerosol particles are spherical or non-spherical. Non-sphericity is detected when the value S = ((Lmax/Lmin)-1)>0.3, where Lmax is the maximum length of the particle and Lmin is the minimum length of the particle. The value of S can be inferred from multi-angular measurements of the departure of scattered radiation from that expected from spherical aerosol particles. These attributes require a polarimeter in addition to a high-resolution imager to attain threshold values The requirement for these products is to provide observations from any satellite carrying the aerosol polarimeter. The requirements below apply only under clear, daytime conditions and are applicable to sub-satellite pixels.

Para. No.		Thresholds	Objectives
40.3.1.4-1	a. Horizontal Cell Size	10 km	1 km
40.3.1.4-2	b. Vertical Coverage	Surface to 30 km	Surface to 50 km
40.3.1.4-3	c. Vertical Cell Size	Total Column	Total Column
40.3.1.4-4	1. [0 to 2 km]		0.25 km
40.3.1.4-5	2. [2 to 5 km]		0.5 km
40.3.1.4-6	3. [> 5 km]		1 km
40.3.1.4-7	D. MEASUREMENT RANGE	1.3 to 1.7 for *m* 0 to 1 for ϖ	1.3 to 1.8 for *m* 0 to 1 for ϖ
40.3.1.4-8	e. Measurement Precision	0.01 for *m* 0.02 for ϖ	0.005 for *m* 0.01 for ϖ
40.3.1.4-9	g. Mapping Uncertainty	4 km	1 km
40.3.1.4-10	h. Measurement Accuracy	0.02 FOR *M* 0.03 FOR ϖ	0.01 for *m* 0.01 for ϖ
40.3.1.4-11	h. Maximum Local Average Revisit Time (S)	N/A	N/A
40.3.1.4-12	i. Deleted.		
40.3.1.4-13	j. Long Term Stability (C)	0.01 FOR *M* 0.02 FOR ϖ	0.005 for *m* 0.01 FOR ϖ

40.3.2 Ozone Total Column/Profile

Ozone total column is defined as the amount of ozone in a vertical column of the atmosphere measured in Dobson Units (milli-atm-cm). Ozone vertical profile is defined as the volumetric concentration of ozone in specified segments of a vertical column of the atmosphere measured in parts per million volume (ppmv). For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which ozone parameters must be reported. Total Column requirements listed below apply under all cloud conditions. TH is Tropopause Height or 8 km, whichever is greater as determined by ancillary data.

Units:
Total column: milli-atm-cm
PROFILE: PPMV

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
40.3.2-1	1. Total Column	50 km @ nadir	50 km
40.3.2-2	2. Profile	250 km	250 km
40.3.2-3	b. Horizontal Reporting Interval	Column: 50 km @ nadir Profile: 250 km	(TBD)
	c. Vertical Cell Size		
40.3.2-4	1. Total Column	60 km	60 km
40.3.2-5	2. Profile, 0 - TH	N/A	3 km
40.3.2-6	3. Profile, TH - 25 km	3 km	1 km
40.3.2-7	4. Profile, 25 - 60 km	3 km	3 km
	d. Vertical Reporting Interval		
40.3.2-8	1. Total Column	N/A	N/A
40.3.2-9	2. Profile	Vertical Cell Size	Vertical Cell Size
40.3.2-10	e. Horizontal Coverage	Solar zenith angles < 80 degrees	Global
40.3.2-11	f. Vertical Coverage		
40.3.2-33	1. Total Column	0 - 60 km	0 - 60 km
40.3.2-34	2. Profile	TH - 60 km	0 - 60 km
	g. Measurement Range		
40.3.2-12	1. Total Column	50 - 650 milli-atm-cm	50 - 650 milli-atm-cm
40.3.2-13	2. Profile, 0 - TH	N/A	0.01 - 3 ppmv
40.3.2-14	3. Profile, TH - 60 km	0.1 - 15 ppmv	0.1 - 15 ppmv
	h. Measurement Accuracy		
40.3.2-15	1. Total Column	15 milli-atm-cm, 450 milli-atm-cm < total column. 12 milli-atm-cm, 250 < total column < 450 milli-atm-cm. 9 milli-atm-cm, total column < 250 milli-atm-cm.	5 milli-atm-cm
40.3.2-16	2. Profile, 0 - TH	N/A	10 %
40.3.2-17	3. Profile, TH – 15 km	Greater of 20% or 0.1 ppmv	10 %
40.3.2-18	4. Profile, 15 – 60 km	Greater of 10% or 0.1 ppmv	5 %
	i. Measurement Precision		
40.3.2-19	1. Total Column	3 milli-atm-cm + 0.5 % of measured ozone, 450 milli-atm-cm < total	1 milli-atm-cm

		column. 2.75 milli-atm-cm + 0.5% of measured ozone, 250 < total column < 450 milli-atm-cm. 2.5 milli-atm-cm +0.5% of measured ozone, total column < 250 milli-atm-cm.	
40.3.2-20	2. Profile, 0 – TH	N/A	10 %
40.3.2-21	3. Profile, TH – 15 km	10%	3 %
40.3.2-22	4. Profile, 15 – 50 km	3%	1 %
40.3.2-23	5. Profile, 50 – 60 km	10%	3 %
	j. Long Term Stability		
40.3.2-24	1. Total Column	1%	0.5 %
40.3.2-25	2. Profile	2%	1 %
	k. Mapping Uncertainty		
40.3.2-26	1. Total Column, at nadir	5 km	5 km
40.3.2-27	2. Profile	25 km	25 km
	l. Maximum Local Average Revisit Time (S)		
40.3.2-28	1. Total Column	24 hrs	24 hrs
40.3.2-29	2. Profile	4 days	24 hrs
	m. Deleted.		
40.3.2-30	1. Deleted.		
40.3.2-31	2. Deleted.		
40.3.2-32	n. Latency (S)	120 minutes	15 minutes

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40.3.3 Precipitable Water

Precipitable water is defined as the total equivalent water of unit cross-sectional area between any two specified levels, including the total atmospheric column. The requirements below apply under both clear and cloudy conditions.

Units: mm of condensed vapor

Para. No.		Threshold	Objectives
40.3.3-1	a. Horizontal Cell Size	25 km	1 km
40.3.3-2	b. Horizontal Reporting Interval	25 km	HCS
40.3.3-3	c. Horizontal Coverage	Global	Global
40.3.3-4	d. Measurement Range	0 - 75 mm	0 - 100 mm
40.3.3-5	e. Measurement Accuracy	Land or Ice Greater of 8% or 2 mm Ocean, Ice-free 1mm	1 mm or 4%
40.3.3-6	f. Measurement Precision	Land or Ice Greater of 5% or 1mm Ocean, Ice-free 1 mm	1 mm
40.3.3-7	g. Mapping Uncertainty	3 km	0.1 km
40.3.3-8	h. Maximum Local Average Revisit Time (S)	8 hrs	3 hrs
40.3.3-9	i. Deleted.		
40.3.3-10	j. Long Term Stability (C)	Greater of 1.0 mm or 10%	Greater of 0.1 mm or 1%
40.3.3-11	k. Latency (S)	90 minutes	15 minutes

40.3.4 Precipitation (Type, Rate)

The required data products are precipitation rate and identification of type as rain or ice. Unless otherwise specified, the requirements in the table below apply to both precipitation type and rate and apply under both clear and cloudy conditions.

Units:
Rate: mm/hr
Type: N/A

Para. No.		Thresholds	Objectives
40.3.4-1	a. Horizontal Cell Size	15 km	0.1 km
40.3.4-2	b. Horizontal Reporting Interval	15 km	0.1 km
40.3.4-3	c. Horizontal Coverage	Global	Global
	d. Measurement Range		
40.3.4-4	1. Precipitation Rate	$\geq$ 0 - 50 mm/hr	0 - 250 mm/hr
40.3.4-5	2. Precipitation Type	Rain and ice	Rain and ice
40.3.4-6	e. Measurement Accuracy, Precip. Rate	Ocean or Ice-free Greater of 1 mm/hr or 10% Land or Ice Greater of 1 mm/hr or 50 %	2 mm/hr
40.3.4-7	f. Measurement Precision, Precip. Rate	Ocean or Ice-free Greater of 2 mm/hr or 20% Land or Ice Greater of 3 mm/hr or 40 %	1 mm/hr
40.3.4-8	g. Correct Typing Probability, Precip. Type	97 %	99 %
40.3.4-9	h. Mapping Uncertainty	3 km	0.1 km
40.3.4-10	i. Maximum Local Average Revisit Time (S)	8 hrs	3 hrs
40.3.4-11	j. Deleted.		
40.3.4-12	k. Long Term Stability (C)	1.0 mm hr^{-1} or 10%	0.1 mm hr^{-1} or 1%

40.3.4-13	l. Latency (S)	90 minutes	15 minutes

40.3.5 Pressure Profile

A pressure profile is a set of estimates of the atmospheric pressure at specified altitudesabove the earth's surface. The requirements below apply under both clear and cloudy conditions.

Units: mb

Para. No.		Thresholds	Objectives
40.3.5-1	a. Horizontal Cell Size	25 km,	5 km
40.3.5-2	b. Horizontal Reporting Interval	25 km	5 km
40.3.5-3	c. Vertical Cell Size	0 km	0 km
	d. Vertical Reporting Interval		
40.3.5-4	1. [0 – 2 km]	1 km	0.25 km
40.3.5-5	2. [2 – 5 km]	1 km	0.5 km
40.3.5-6	3. [> 5 km]	1 km	1 km
40.3.5-7	e. Horizontal Coverage	Global	Global
40.3.5-8	f. Vertical Coverage	0 - 30 km	0 - 30 km
40.3.5-9	g. Measurement Range	10 - 1050 mb	10 - 1050 mb
	h. Measurement accuracy		
40.3.5-10	1. [0 – 2 km]	3%	
40.3.5-11	2. [2 – 10 km]	3 %	0.5%
40.3.5-12	3. [10 – 30 km]	5 % [10-30 km]	0.5 %
40.3.5-13	i. Measurement Precision	3 mb	2 mb
40.3.5-14	j. Mapping Uncertainty	3 km	1 km
40.3.5-15	k. Maximum Local Average Revisit Time (S)	8 hrs	1 hr
40.3.5-16	l. Deleted.		
40.3.5-17	m. Latency (S)	156 minutes	15 minutes

40.3.6 Total Water Content

Total water content is defined as the water vapor, cloud liquid water, and cloud ice liquid equivalent in specified segments of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported. The requirements below apply under both clear and cloudy conditions.
Units: kg/m^2

Para. No.		Thresholds	Objectives
40.3.6-1	a. Horizontal Cell Size	20 km	10 km
40.3.6-2	b. Horizontal Reporting Interval	20 km	10 km
40.3.6-3	c. Vertical Cell Size	3 km	1 km
40.3.6-4	d. Vertical Reporting Interval	Vertical cell size	Vertical cell size
40.3.6-5	e. Horizontal Coverage	Global	Global,
40.3.6-6	f. Vertical Coverage	0 - 20 km	0 - (TBD) km
40.3.6-7	g. Measurement Range	0 - 60 kg/m^2	(TBD)
	h. Measurement Uncertainty		
40.3.6-8	1. Point Measurement	1.2 kg/m^2 ; Non-precipitating Greater of 2.2 kg/m^2 or 15 % ; Precipitating	(TBD)
40.3.6-9	2. Global Average	0.25 kg/m^2	(TBD)
40.3.6-10	i. Mapping Uncertainty	3 km	3 km
40.3.6-11	j. Maximum Local Average Revisit Time (S)	8 hrs	3 hrs
40.3.6-12	k. Deleted		
40.3.6-13	l. Latency (S)	90 minutes	15 minutes

40.4 Cloud EDRs

In this section "cloud" always means "detectable cloud" as defined in the glossary.

40.4.1 Cloud Base Height

Cloud base height is defined as the height above ground level where cloud bases occur. More precisely, for a cloud covered earth location, cloud base height is the set of altitudes of the bases of the clouds that intersect the local vertical at this location. The reported heights are horizontal spatial averages over a cell, i.e., a square region of the earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. As a threshold, only the height of the base of the lowest altitude cloud layer is required and the objective is to report cloud base height for all distinct cloud layers.

Units: km

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.1-1	1. Moderate	10 km	1.0 km
40.4.1-10	2. Fine, nadir	6 km	1.0 km
40.4.1-2	b. Horizontal Reporting Interval	HCS	HCS
40.4.1-3	c. Horizontal Coverage	Global	Global
	d. Vertical Cell Size	N/A	N/A
40.4.1-4	e. Vertical Reporting Interval	Base of highest cloud and lowest cloud	Base of all distinct cloud layers
40.4.1-5	f. Measurement Range	0 – 20 km	0 – 30 km
40.4.1-6	g. Measurement Uncertainty	2 km	0.25 km
40.4.1-7	h. Mapping Uncertainty	1.5 km	1 km
40.4.1-8	i. Maximum Local Average Revisit Time (S)	6 hrs	4 hrs
40.4.1-9	j. Deleted.		
40.4.1-11	k. Long Term Stability (C)	2.0 km	0.1 km
40.4.1-12	l. Latency (S)	90 minutes	15 minutes

40.4.2 Cloud Cover/Layers

Cloud cover is defined as the fraction of a given area on the earth's surface for which a locally normal line segment, extending between two given altitudes, intersects a cloud. As a threshold, cloud cover is required for up to four layers of the atmosphere between the surface and an altitude of 20 km. As an objective, cloud cover is required for contiguous, 0.1 km thick layers at 0.1 km increments in altitude, from the surface of the earth to an altitude of 30 km. The product will also include a binary (cloudy/not cloudy) map indicating the HCSs which contain clouds.

Units: Dimensionless

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.2-1	1. Moderate	25 km	1 km
40.4.2-12	2. Fine, nadir	6 km	1 km
40.4.2-2	b. Horizontal Reporting Interval	HCS	(TBD)
	c. Vertical Cell Size	N/A	N/A
40.4.2-3	d. Vertical Reporting Interval	4 layers	0.1 km
40.4.2-4	e. Horizontal Coverage	Global	Global
40.4.2-5	f. Vertical Coverage	0 - 20 km	0 - 30 km
40.4.2-6	g. Measurement Range	0 - 1.0 HCS Area	0 - 1.0
40.4.2-7	h. Measurement Accuracy	0.07 HCS area (nadir) 0.1 HCS area (EOS)	0.05
40.4.2-8	i. Measurement Precision	0.07 HCS area (nadir) 0.15 HCS area (EOS)	0.025
40.4.2-9	j. Mapping Uncertainty	1.5 km	1 km
40.4.2-10	k. Max Local Average Revisit Time (S)	6 hrs	4 hrs
40.4.2-11	l. Deleted.		
40.4.2-13	m. Latency (S)	90 minutes	15 minutes
40.4.2-14	n. Binary Map HCS	Pixel Size	
40.4.2-15	o. Binary Map HRI	HCS	
40.4.2-16	p. Binary Map Measurement Range	Cloudy/not cloudy	
40.4.2-17	q. Binary Map Probability of Correct typing	Day, Ocean, OD $\leq$ 0.5 92% Day, Ocean, OD > 0.5 99% Day, Land, OD $\leq$ 1 85% Day, Land OD > 1 93% Night, Ocean OD $\leq$ 0.5 90% Night, Ocean, OD > 0.5 96% Night, Land, OD $\leq$ 1 85% Night, Land, OD > 1 90%	

40.4.3 Cloud Effective Particle Size

Effective cloud particle size is defined as the ratio of the third moment of the drop size distribution to the second moment, averaged over a layer of air within a cloud.

Units: μm

Para. No.		Threshold	Objectives
40.4.3-1	a. Horizontal Cell Size	25 km (Moderate, EOS) 5 km (Fine, nadir)	10 km
40.4.3-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.4.3-3	c. Vertical Cell Size	Vertical Reporting Interval	Vertical Reporting Interval
40.4.3-4	d. Vertical Reporting Interval	Up to 4 layers	0.3 km
40.4.3-5	e. Horizontal Coverage	Global	Global
40.4.3-6	f. Vertical Coverage	0 - 20 km	0 - 30 km
40.4.3-7	g. Measurement Range	0 - 50 μm	(TBD)
40.4.3-8	h. Measurement Accuracy	5.5μm (Day, water, OD $\leq$ 1) 8μm (Day, ice, OD $\leq$ 1) 2μm (Day, water, OD > 1) 3.5μm (Day, ice, OD > 1) 4μm (Night)	Greater of 5% or 2 μm
40.4.3-9	i. Measurement Precision	1μm (Day, water) 1.5μm (Day, ice,) 2μm (Night)	2%
40.4.3-10	j. Long Term Stability	2%	1%
40.4.3-11	k. Mapping Uncertainty	1.5 km	1 km
40.4.3-12	l. Maximum Local Average Revisit Time (S)	6hrs	3 hrs
40.4.3-13	m. Deleted.		
40.4.3-14	n. Latency (S)	90 minutes	15 minutes
40.4.3-15	o. Fine Measurement Uncertainty	5.5μm (Day, water, OD $\leq$ 1) 12μm (Day, ice, OD $\leq$ 1) 2.5μm (Day, water, OD > 1) 4μm (Day, ice, OD > 1) 4μm (Night)	

40.4.4 Cloud Ice Water Path

Cloud ice water path is defined as the equivalent amount of water within cloud ice particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud ice water path must be reported.

Units: kg/mm^2

Para. No.		Thresholds	Objectives
40.4.4-1	a. Horizontal Cell Size	50 km	10 km
40.4.4-2	b. Horizontal Reporting Interval	50 km	10 km
40.4.4-3	c. Vertical Cell Size	N/A(Total Column)	Vertical Reporting Interval
40.4.4-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
40.4.4-5	e. Horizontal Coverage	Global	Global
40.4.4-6	f. Vertical Coverage	0 - 20 km	0 - 30 km
40.4.4-7	g. Measurement Range	0.3 to 2.6 kg/m^2	0 to 2 mm
40.4.4-8	h. Measurement Accuracy	25%	0.05 mm or 10%
40.4.4-9	i. Measurement Precision	50 %	0.02 mm or 4%
40.4.4-10	j. Long Term Stability	2%	1%
40.4.4-11	k. Mapping Uncertainty	3 km	1 km
40.4.4-12	l. Max Local Average Revisit Time (S)	8 hrs	3 hrs
40.4.4-13	m. Deleted.		
40.4.4-14	n. Latency (S)	156 minutes	15 minutes

40.4.5 Cloud Liquid Water

Cloud liquid water is defined as the equivalent amount of water within non-precipitating clouds in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported.

Units: kg/m^2

Para. No.		Thresholds	Objectives
40.4.5-1	a. Horizontal Cell Size	20 km	5 km
40.4.5-2	b. Horizontal Reporting Interval	20 km	5 km
40.4.5-3	c. Vertical Cell Size	N/A (Total Column)	Vertical Reporting Interval
40.4.5-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
40.4.5-5	e. Horizontal Coverage	Global	Global
40.4.5-6	f. Vertical Coverage	0 - 20 km	0 - 30 km
40.4.5-7	g. Measurement Range	0.005 to 1 kg/m^2	0 – 2 kg/m^2
	h. Measurement Uncertainty		
40.4.5-8	1. Over ocean	Ice-free, no precip 0.08 kg/m^2 Ice-free with precip 0.23 kg/m^2	0.01 kg/m^2
40.4.5-9	2. Over land or ice	No precip 0.21 kg/m^2 Precip 0.23 kg/m^2	0.01 kg/m^2
40.4.5-10	i. Mapping Uncertainty	3 km	1 km
40.4.5-11	j. Max Local Average Revisit Time (S)	8 hrs	4 hrs
40.4.5-12	k. Deleted.		
40.4.5-13	l. Long Term Stability (C)	Greater of 0.05 mm or 10%	Greater of 0.01 mm or 1%
40.4.5-14	m. Latency (S)	90 minutes	15 minutes

40.4.6 Cloud Optical Thickness

(IORD Name: Cloud Optical Depth/Transmissivity)
Cloud optical thickness is defined as the extinction (scattering + absorption) vertical optical thickness of each and every distinguishable cloud layer in a vertical column of the atmosphere as well as the total optical thickness of all layers in aggregate. Optical thickness (τ) is related to transmittance (t) by $t = \exp(-\tau)$.
Units: Dimensionless

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.6-1	1. Moderate	25 km	10 km
40.4.6-11	2. Fine, nadir	5 km	1 km
40.4.6-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.4.6-3	c. Horizontal Coverage	Global	Global
40.4.6-4	d. Measurement Range	0.1 to 64 (τ units) Day, water 0.1 to 10 (τ units) Day, ice 0.5 to 10 (τ units) Night, ice	(TBD)
40.4.6-5	e. Measurement Accuracy	0.28 (τ units) Day, water, OD $\leq$ 1 0.08 (τ units) Day, ice, OD $\leq$ 1 0.16 (τ units) Night, ice, OD $\leq$ 1 10% Day, water, OD > 1 5% Day, ice, OD > 1 10% Night, Ice, OD > 1	5 %
40.4.6-6	f. Measurement Precision	0.1 (τ units) Day, water, OD $\leq$ 1 0.023 (τ units) Day, ice, OD $\leq$ 1 0.025 (τ units) Night, ice, OD $\leq$ 1 4 % Day, water, OD>1 3 % Day, ice OD > 1 5 % Night, ice OD > 1	Greater of 2 % or (TBD)
40.4.6-7	g. Long Term Stability	2 %	1 %
40.4.6-8	h. Mapping Uncertainty	1.5 km	1 km
40.4.6-9	i. Max Local Average Revisit Time (S)	8 hrs	3 hrs
40.4.6-10	j. Deleted.		
40.4.6-12	k. Latency (S)	90 minutes	15 minutes
40.4.6-13	l. Fine Measurement Uncertainty	0.3 (τ units) Day, water, OD $\leq$ 1 0.1 (τ units) Day, ice, OD $\leq$ 1 0.16 (τ units) Night, ice, OD $\leq$ 1 10% Day, water, OD > 1 10% Day, ice, OD > 1 10% Night, Ice, OD > 1	

40.4.7 Cloud Top Height

Cloud top height is defined for each cloud-covered earth location as the set of heights of the tops of the cloud layers overlying the location. The reported heights are horizontal spatial averages over a cell, i.e., a square region of the earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. Cloud top height is not defined or reported for cells that are clear. As a threshold, the height at the top of up to four cloud layers is required. The objective is to report the cloud top height for all distinct cloud layers.

Units: km

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.7-1	1. Moderate	25 km	1 km
40.4.7-13	2. Fine, nadir	5 km	1 km
40.4.7-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.4.7-3	c. Horizontal Coverage	Global	Global
	d. Vertical Cell Size	N/A	N/A
40.4.7-4	e. Vertical Reporting Interval	Up to 4 layers	Top of all distinct cloud layers
40.4.7-5	f. Measurement Range	0-20 km	(TBD)
	g. Measurement Accuracy		
40.4.7-6	1. Cloud layer optical thickness > 0.1 (TBR)	0.5 km Day, water, OT > 1 1 KM NIGHT, WATER OT > 1 1 km Ice OT > 1	0.3 km
40.4.7-7	2. Cloud layer optical thickness ≤ 0.1 (TBR)	2 km OT ≤ 1	0.3 km
40.4.7-8	h. Measurement Precision	0.3 km	0.15 km
40.4.7-9	i. Long Term Stability	0.2 km	0.1 km
40.4.7-10	j. Mapping Uncertainty	1.5 km	1 km
40.4.7-11	k. Maximum Local Average Revisit Time (S)	6 hrs	4 hrs
40.4.7-12	l. Deleted.		
40.4.7-14	m. Latency (S)	90 minutes	15 minutes
40.4.7-15	n. Fine, Measurement Uncertainty	0.5 km Day, water, OT > 1 1 KM NIGHT, WATER OT > 1 2 km Day, night, water 1 km Ice	

40.4.8 Cloud Top Pressure

Cloud top pressure is defined for each cloud-covered earth location as the set of atmospheric pressures at the tops of the cloud layers overlying the location. The reported pressures are horizontal spatial averages over a cell, i.e., a square region of the earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. Cloud top pressure is not defined or reported for cells that are clear. As a threshold, only the pressure at the top of the highest altitude cloud layer is required. The objective is to report the cloud top pressure for all distinct cloud layers.

Units: mb

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.8-1	1. Moderate	12.5 km	1 km
40.4.8-17	2. Fine, nadir	5 km	1 km
40.4.8-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.4.8-3	c. Horizontal Coverage	Global	Global
40.4.8-4	d. Measurement Range	50 to 1050 mb	(TBD)
	e. Measurement Accuracy		
40.4.8-5	1. [Surface - 3 km]	100 mb OT $\leq$ 1, day/night, water 40 mb OT > 1 day, water 70 mb OT > 1 night, water	30 mb
40.4.8-6	2. [3 - 7 km]	65 mb OT $\leq$ 1 40 mb OT > 1	22 mb
40.4.8-7	3. [> 7 km]	30 mb	15 mb
	f. Measurement Precision		
40.4.8-8	1. [Surface - 3 km]	25 mb	10 mb
40.4.8-9	2. [3 - 7 km]	20 mb	7 mb
40.4.8-10	3. [> 7 km]	13 mb	5 mb
	g. Long Term Stability (TBR)		
40.4.8-11	1. [Surface - 3 km]	10 mb	3 mb
40.4.8-12	2. [3 - 7 km]	7 mb	2 mb
40.4.8-13	3. [> 7 km]	5 mb	1 mb
40.4.8-14	h. Mapping Uncertainty	1.5 km	1 km
40.4.8-15	i. Maximum Local Average Revisit Time (S)	8 hrs	3 hrs
40.4.8-16	j. Deleted.		
40.4.8-18	k. Latency (S)	90 minutes	15 minutes
	l. Fine Measurement Uncertainty		
40.4.8-19	1. [Surface to 3 km]	130 mb OT $\leq$ 1, day, water 100 mb OT < 1 night, water 40 mb OT > 1 day, water 80 mb OT > 1 night, water	
40.4.8-20	2. [3 – 7 km]	70 mb OT $\leq$ 1 45 mb OT > 1	
40.4.8-21	3. [> 7 km]	30 mb	

40.4.9 Cloud Top Temperature

Cloud top temperature is defined for each cloud-covered earth location as the set of atmospheric temperatures at the tops of the cloud layers overlying the location. The reported temperatures are horizontal spatial averages over a cell, i.e., a square region of the earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. Cloud top temperature is not defined or reported for

cells that are clear. As a threshold, only the temperature at the top of the highest altitude cloud layer is required. The objective is to report the cloud top temperature for all distinct cloud layers.

Units: K

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.4.9-1	1. Moderate	25 km	1 km
40.4.9-12	2. Fine, nadir	5 km	1 km
40.4.9-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.4.9-3	c. Horizontal Coverage	Global	Global
40.4.9-4	d. Measurement Range	175 to 310 K	(TBD)
	e. Measurement Accuracy		
40.4.9-5	1. Cloud layer optical thickness > 0.1 (TBR)	2 K OT>1, Water cloud, Day 3 K OT>1, Water cloud, Night 3 K OT>1, Ice Cloud	1.5 K
40.4.9-6	2. Cloud layer optical thickness ≤ 0.1 (TBR)	6 K OT < 1	(TBD)
40.4.9-7	f. Measurement Precision	1.5 K	0.5 K
40.4.9-8	g. Long Term Stability	1 K	0.1 K
40.4.9-9	h. Mapping Uncertainty	1.5 km	1 km
40.4.9-10	i. Maximum Local Average Revisit Time (S)	6 hrs	6 hrs
40.4.9-11	j. Deleted.		
40.4.9-13	k. Latency (S)	90 minutes	15 minutes
40.4.9-14	l. Fine Measurement Uncertainty	3 K Water 5 K Ice	

40.4.10 Cloud Particle Size Distribution

The effective radius r_e and effective variance ν_e of a single mode particle size distribution. The effective radius is the ratio of the third moment of the size distribution to the second moment. The effective variance characterizes the width of the size distribution (∉ - applies only to sub-satellite pixels). These attributes require a polarimeter in addition to a high-resolution imager to attain threshold values. The refresh requirement for the Cloud Particle Size Distribution product is to provide observations from the satellite nadir-track of any satellite carrying the aerosol polarimeter.

Units: μm

Para. No.		Thresholds	Objectives
40.4.10-1	a. Horizontal Cell Size	15 km	5 km
40.4.10-2	b. Vertical Reporting Interval	1 km	0.3 km
40.4.10-3	C. MEASUREMENT RANGE	0 to 50 for r_e 0 to 2 for ν_e	0 to 80 for r_e 0 to 3 for ν_e
40.4.10-4	e. Measurement Precision	Greater of 0.5 μm or 5 % for r_e Greater of 0.04 μm or 40 % for ν_e	Greater of 0.3 μm or 3 % for r_e Greater of 0.03 μm or 30 % for ν_e
40.4.10-5	g. Mapping Uncertainty	4 km	1 km
40.4.10-6	h. Measurement Accuracy	Greater of 1.0 μm or 10 % for r_e GREATER OF 0.05 μM OR 50 % FOR ν_E	Greater of 0.5 μm or 5 % for r_e Greater of 0.04 μm or 40 % for ν_e
40.4.10-7	h. Maximum Local Average Revisit Time (S)	N/A	N/A
40.4.10-8	i. Deleted		
40.4.10-9	j. Long Term Stability (C)	Greater of 0.5 μm or 5 % for r_e Greater of 0.04 μm or 40 % for ν_e	Greater of 0.3 μm or 3 % for r_e GREATER OF 0.03 μM OR 30 % FOR ν_E

40.5 Earth Radiation Budget EDRs

All requirements for Earth Radiation Budget EDRs below apply under both clear and cloudy conditions except for the Surface Albedo.

40.5.1 Net Solar Radiation (TOA)

Net solar radiation is the difference between the incoming solar radiation flux (all wavelengths) at the top of the atmosphere and the outgoing reflected flux (all wavelengths) at the top of the atmosphere. This parameter is sometimes called "net short-wave radiation (TOA)" since solar radiation is mainly contained in the 0.4 - 4 μm band.

Units: W/m^2

Para. No.		Thresholds	Objectives
40.5.1-1	a. Horizontal Cell Size, nadir	25 km	10 km
40.5.1-2	b. Horizontal Reporting Interval	HCS	HCS
40.5.1-3	c. Horizontal Coverage	Global	Global
40.5.1-4	d. Measurement Range	0 – 1400 W/m^2	0 - 1400 W/m^2
40.5.1-5	e. Measurement Accuracy	3 W/m^2	1 W/m^2
40.5.1-6	f. Measurement Precision	15 W/m^2	5 W/m^2
40.5.1-7	g. Mapping Uncertainty	5 km	2 km
40.5.1-8	h. Max Local Average Revisit Time (S)	24 hrs	12 hrs
40.5.1-9	i. Deleted.		
40.5.1-10	j. Deleted		
40.5.1-11	k. Long Term Stability (C)	0.2 W/m^2	0.1 W/m^2
40.5.1-12	l. Latency	150 minutes	60 minutes

40.5.2 Albedo (Surface)

Surface albedo is defined as the total amount of solar radiation in the 0.4 to 4.0 micron band reflected by the Earth's surface into an upward hemisphere (sky dome), including both diffuse and direct components, divided by the total amount incident from this hemisphere, including both direct and diffuse components. This EDR is required during daytime only and under clear conditions only. This is an instantaneous, not a time-averaged, measurement.

Units: Dimensionless

Para. No.		Threshold	Objectives
40.5.2-1	a. Horizontal Cell Size (Mod, EOS)	1.6 km	0.5 km
40.5.2-13	Horizontal Cell Size (Fine, nadir)	0.75 km	0.5 km
40.5.2-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.5.2-3	c. Horizontal Coverage	Global	Global
40.5.2-4	d. Measurement Range	0 - 1.0 units of albedo	0 - 1.0
40.5.2-5	e. Measurement Accuracy	0.025 units of albedo	0.0125
40.5.2-6	f. Measurement Precision	0.02 units of albedo	0.01
40.5.2-7	g. Long Term Stability	0.01 units of albedo	0.01
40.5.2-8	h. Mapping Uncertainty	1.5 km	1.0 km
40.5.2-9	i. Max Local Average Revisit Time (S)	24 hrs	4 hrs
40.5.2-10	j. Deleted.		
40.5.2-11	k. Latency (S)	150 minutes	60 minutes
40.5.2-12	l. Fine Measurement Uncertainty	0.03 units of albedo	

40.5.3 Downward Long-wave Radiation (Surface)

Downward long-wave radiation (surface) is defined as the irradiance in the 5 - 100 μm wavelength band incident downward at the surface of the earth. Physical measurements are not required in the entire 5-100 μm band as long as the reported value meets the accuracy requirement specified below. This is an instantaneous, not a time-averaged, measurement.

Units: W/m^2

Para. No.		Thresholds	Objectives
40.5.3-1	a. Horizontal Cell Size, nadir	25 km	10 km
40.5.3-2	b. Horizontal Reporting Interval	HCS	HCS
40.5.3-3	c. Horizontal Coverage	Global	Global
40.5.3-4	d. Measurement Range	0 - 500 W/m^2	0 - 500 W/m^2
40.5.3-5	e. Measurement Accuracy	10 W/m^2 (TBR)	3 W/m^2
40.5.3-6	f. Measurement Precision	20 W/m^2	6 W/m^2
40.5.3-7	g. Mapping Uncertainty	5 km	1 km
40.5.3-8	h. Max Local Average Revisit Time (S)	12 hrs (1/day, 1/night)	4 hrs
40.5.3-9	i. Latency	150 minutes	60 minutes
40.5.3-10	j. Long Term Stability (C)	0.5 W/m^2	0.2 W/m^2
40.5.3-11	k. Deleted		

40.5.4 Downward Short-wave Radiation (Surface)

(IORD Name: Insolation)
Downward short-wave radiation (surface) is defined as the irradiance at wavelengths less than 4 μm incident downward at the surface of the earth. This is an instantaneous, not a time-averaged, measurement.

Units: W/m^2

Para. No.		Thresholds	Objectives
40.5.4-1	a. Horizontal Cell Size, nadir	25 km	10
40.5.4-2	b. Horizontal Reporting Interval	HCS	HCS
40.5.4-3	c. Horizontal Coverage	Global	Global
40.5.4-4	d. Measurement Range	0 - 1400 W/m^2	0 - 1400 W/m^2
40.5.4-5	e. Measurement Accuracy	10 W/m^2	3 W/m^2
40.5.4-6	f. Measurement Precision	20 W/m^2	6 W/m^2
40.5.4-7	g. Mapping Uncertainty	5 km	2 km
40.5.4-8	h. Max Local Average Revisit Time (S)	24 hrs	8 hrs
40.5.4-9	i. Latency	150 minutes	60 minutes
40.5.4-10	j. Long Term Stability (C)	0.5 W/m^2	0.2 W/m^2
40.5.4-11	k. Deleted		

40.5.5 Outgoing Long-wave Radiation (Top of Atmosphere)

(IORD Name: Total Long-wave Radiation)
Outgoing long-wave radiation (top of atmosphere - TOA) is defined as the outgoing (upward) flux of long-wave radiation (5 - 100 μm) at the top of the atmosphere. This is an instantaneous, not a time-averaged, measurement.

Units: W/m^2

Para. No.		Thresholds	Objectives
40.5.5-1	a. Horizontal Cell Size, nadir	25 km	10 km
40.5.5-2	b. Horizontal Reporting Interval	HCS	HCS
40.5.5-3	c. Horizontal Coverage	Global	Global
40.5.5-4	d. Measurement Range	0 – 500 W/m^2	0 - 500 W/m^2
40.5.5-5	e. Measurement Accuracy	5 W/m^2	2 W/m^2
40.5.5-6	f. Measurement Precision	12 W/m^2	5 W/m^2
40.5.5-7	g. Mapping Uncertainty	5 km	2 km
40.5.5-8	h. Maximum Local Average Revisit Time (S)	12 hours (once/daytime & once/nighttime)	4 hr
40.5.5-9	i. Latency.	150 minutes	60 minutes
40.5.5-10	j. Long Term Stability (C)	0.2 W/m^2	0.1 W/m^2
40.5.5-11	k. Deleted		

40.5.6 Solar Irradiance

Solar irradiance is the radiated power incident on a surface orthogonal to the line of sight to the sun from the location of the spacecraft. The total irradiance (all wavelengths) and the spectral (0.2 – 2.0 μm) irradiance, are to be reported.

Units: W/m^2

Para. No.		Thresholds	Objectives
	a. Measurement Range		
40.5.6-1	1. Total	1310 – 1420 W/m^2	1310 - 1420 W/m^2
40.5.6-2	2. Spectral (0.2 - 2.0 μm)	0 - 10 W/m^2/nm	0 - 10 W/m^2/nm
40.5.6-3	Deleted		
	b. Measurement Uncertainty		
40.5.6-4	1. Total	1.5 W/m^2	0.5 W/m^2
40.5.6-5	2. Spectral (0.2 – 2.0 μm)	1 %	0.1 %
40.5.6-6	Deleted		
	c. Long Term Stability		
40.5.6-7	1. Total (C)	0.002 %/yr	0.0005 %/yr
	2. Spectral (0.2 - 2.0 μm) (C)		
40.5.6-9	Deleted		
40.5.6-11	a. [λ < 0.6 μm]	0.02 %/yr	0.01 %/yr
40.5.6-12	b. [λ > 0.6 μm]	0.01 %/yr	0.01 %/yr
40.5.6-10	d. Reporting Frequency	20 min of viewing sun per orbit, one satellite	20 min of viewing sun per orbit, for each of three satellites
40.5.6-13	e. Measurement Precision		
40.5.6-14	1. Total	0.002%/yr	0.0005%/yr
40.5.6-15	2. . Spectral (0.2 - 2.0 μm)	0.02 %/yr	0.01 %/yr
40.5.6-16	f. Spectral Resolution		
40.5.6-17	1. [λ < 0.28 μm]	1 nm	0.1 nm
40.5.6-18	2. [0.28 < λ < 0.4 μm]	5 nm	0.1 nm
40.5.6-19	3. [λ > 0.40 μm]	35 nm	1.0 nm
40.5.6-20	g. Latency	150 minutes	60 minutes

40.6 Land EDRs

40.6.1 Land Surface Temperature

Land surface temperature (LST) is defined as the skin temperature of the uppermost layer of the land surface. This EDR is required under clear conditions only.

Units: K

Para. No.		Threshold	Objectives
40.6.1-1	a. Horizontal Cell Size (nadir)	0.75 km	1 km
40.6.1-12	Horizontal Cell Size (EOS)	1.3 km	1 km
40.6.1-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.6.1-3	c. Horizontal Coverage	Land	Land
40.6.1-4	d. Measurement Range	213 K - 343 K	183 K - 343 K
40.6.1-5	e. Measurement Accuracy	2.4 K	1 K
40.6.1-6	f. Measurement Precision	0.5 K	0.025 K
40.6.1-7	g. Mapping Uncertainty	1.5 km	1 km
40.6.1-8	h. Max Local Average Revisit Time (S)	6 hrs	3 hrs
40.6.1-9	i. Deleted.		
40.6.1-10	j. Latency (S)	90 minutes	15 minutes
40.6.1-11	k. Measurement Uncertainty, Nadir	2.50 K	

40.6.2 Vegetation Index

Normalized difference vegetation index (Top of the Atmosphere) is most directly related to absorption of photosynthetically active radiation, but is often correlated with biomass or primary productivity. Red spectral measurements are sensitive to the chlorophyll content of vegetation and the near IR to the mesophyll structure of leaves. The normalized ratio (IR-Red)/(IR+ Red) has a close relationship with the photosynthetic capacity of specific vegetation types.

The NASA/NOAA NDVI (for AVHRR-3) is defined as follows:

NDVI = RATIO of [(Reflectance band 2 - reflectance band 1)/ sum],
where: Band 2 = NIR band (0.72-1.0 microns);
Band 1 = VIS band (0.572-0.703 microns).

These specific spectral ranges are not required.
This product also contains a Top of the Canopy Enhanced Vegetation Index (EVI) which is defined as an index using three or more bands and of an appropriate derived functional form designed to be more robust than NDVI under variations in atmospheric conditions and soil properties. The requirements below apply only under clear, daytime conditions.

Units: Dimensionless

Para. No.		Threshold	Objectives
40.6.2-1	a. Horizontal Cell Size (Mod, EOS)	0.8 km	1 km
40.6.2-15	Horizontal Cell Size (Fine, nadir)	0.375 km	1 km
40.6.2-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.6.2-3	c. Horizontal Coverage	Land	(TBD)
40.6.2-4	d. Measurement Range	-1 to +1 NDVI units -1 to +1 EVI units	-1 to +1 NDVI units
40.6.2-5	e. Measurement Accuracy	0.016 NDVI units (Mod)	0.03 NDVI units
40.6.2-6	f. Measurement Precision	0.02 NDVI units (Mod)	0.02 NDVI units
40.6.2-7	g. Long Term Stability	0.01 NDVI units	0.04 NDVI units
40.6.2-8	h. Mapping Uncertainty	1.5 km EOS; 0.4 km (nadir)	1 km
40.6.2-9	i. Max Local Average Revisit Time (S)	24 hrs	24 hrs
40.6.2-10	j. Deleted.		
40.6.2-11	k. Measurement Uncertainty for EVI	0.11 units of EVI	
40.6.2-12	l. Long Term Stability (C)	0.04 NDVI units	0.04 NDVI units
40.6.2-13	m. Latency (S)	90 minutes	15 minutes
40.6.2-14	n. Fine Measurement Uncertainty, NDVI	0.020 NDVI units	

40.6.3 Snow Cover/Depth

Horizontal and vertical extent of snow cover. As a threshold, only fraction of snow cover in the specified horizontal cell (clear or cloudy) is required, regardless of depth. As an objective, fraction of snow cover for snow having a specified minimum depth is required in the specified horizontal cell for a set of specified minimum depths. In addition, a binary product will give a snow/no snow flag.

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.6.3-1	1.Clear	0.8 km (nadir) 1.6 km (EOS)	1 km
40.6.3-2	2. All weather and/or nighttime	12.5 km	1 km
40.6.3-3	b. Horizontal Reporting Interval	HCS	1 km
40.6.3-4	c. Snow Depth Ranges	Snow/No snow	> 8 cm, > 15 cm, > 30 cm, >51 cm, >76 cm
40.6.3-5	d. Horizontal Coverage	Land Snow/No snow	Land & Ice
40.6.3-6	e. Vertical Coverage	Land	0 - 1 m
40.6.3-7	f. Measurement Range	0 – 1 HCS	0 - 1 per snow depth category
	g. Measurement Uncertainty		
40.6.3-8	1.. Clear - daytime	10 % (snow/no snow)	10 % for snow depth
40.6.3-9	2. Cloudy and/or nighttime	20 % (snow/no snow)	10 %
	h. Mapping Uncertainty		
40.6.3-10	1. Clear	1.5 km (EOS)	1 km
40.6.3-11	2. Cloudy	3 km (EOS)	1 km
40.6.3-12	i. Max Local Average Revisit Time (S)	12 hrs	3 hrs
40.6.3-13	j. Deleted.		
40.6.3-14	k. Binary HCS	Clear, day, nadir 0.4 km Clear, day, EOS 0.8 km	
40.6.3-15	l. Sensing Depth (all weather)	0 to 40 cm	1 m
40.6.3-16	m. Long Term Stability (C)	10 %	1% continental
40.6.3-17	n. Latency (S)	90 minutes	15 minutes
40.6.3-18	o. Binary Map- Measurement Range	Snow/No Snow	
40.6.3-19	p. Binary Map- Probability of Correct Typing	95%	

40.6.4 Surface Type

Surface type is defined as one of the seventeen International Geosphere Biosphere Program (IGBP) classes defined below. Estimation of the percentage of vegetation cover per type in each cell is an objective. The requirements below apply in both clear and cloudy conditions. Each given area shall be classified as one of the following types:

Land Cover Class	Definition
1. Evergreen Needleleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Almost all trees remain green all year. Canopy is never without green foliage.
2. Deciduous Needleleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of seasonal, needleleaf tree communities with an annual cycle of leaf-on and leaf-off periods.
3. Evergreen Broadleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Almost all trees and shrubs remain green all year. Canopy is never without green foliage.
4. Deciduous Broadleaf Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.
5. Mixed Forests	Lands dominated by woody vegetation with a percent cover >60% and height exceeding 2 meters. Consists of tree communities with interspersed mixtures or mosaics of the other four forest types. None of the forest types exceeds 60% of landscape.
6. Closed Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover >60%. The shrub foliage can be either evergreen or deciduous.
7. Open Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover between 10-60%. The shrub foliage can be either evergreen or deciduous.
8. Woody Savannas	Lands with herbaceous and other understory systems, and with forest canopy cover between 30-60%. The forest cover height exceeds 2 meters.
9. Savannas	Lands with herbaceous and other understory systems, and with forest canopy cover between 10-30%. The forest cover height exceeds 2 meters.
10. Grasslands	Lands with herbaceous types of cover. Tree and shrub cover is less than 10%.
11. Permanent Wetlands	Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present in either salt, brackish, or fresh water.
12. Croplands	Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Note than perennial woody crops will be classified as the appropriate forest or shrubland cover type.
13. Urban and Built-Up	Land covered by buildings and other man-made structures.
14. Cropland/Natural Vegetation Mosaics	Lands with a mosaic of croplands, forests, shrubland, and grasslands in which no one component comprises more than 60% of the landscape.
15. Snow and Ice	Lands under snow/ice cover.
16. Barren	Lands with exposed soil, sand, rocks, or snow and never have more than 10% vegetated cover during any time of the year.
17. Water Bodies	Oceans, seas, lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.

Units:
Type: N/A
Vegetation Cover: per cent

Para. No.		Threshold	Objectives
40.6.4-1	a. Horizontal Cell Size	1 km	0.25 km
40.6.4-2	Deleted		
40.6.4-3	b. Horizontal Reporting Interval	HCS	(TBD)
40.6.4-4	c. Horizontal Coverage	Land	Land
40.6.4-5	Deleted		
	d. Measurement Range		
40.6.4-6	1. Vegetation/surface type	17 Types (Specified above)	17 Types (Specified above)
40.6.4-7	2. Vegetation cover	0 - 100 %	0 - 100 %
40.6.4-8	e. Measurement Accuracy (veg. cover)	20%	2 %
40.6.4-9	f. Measurement Precision (veg. cover)	10 %	0.1 %
40.6.4-10	g. Correct Typing Probability (vegetation /surface type)	88 %	98 %
40.6.4-11	h. Mapping Uncertainty	1.5 km	1 km
40.6.4-12	i. Max Local Average Revisit Time (S)	24 hrs	3 hrs
40.6.4-13	j. Deleted.		
40.6.4-14	k. Latency (S)	90 minutes	15 minutes

40.6.4.1 **Active Fires (Application of Surface Type EDR)**

Active surface fires are natural or anthropogenic fires. This application of the Surface Type EDR provides (a) geolocation of the pixels in which active fires are detected, (b) the sub-pixel average temperature of each active fire, and (c) the sub-pixel area of each active fire. The number of bands for which these products are provided is algorithm dependent and therefore TBD. A global, binary "fire/no fire" map is neither required nor desired. The products for this application are desired during both day and night time for clear-sky conditions and within clear areas under conditions of broken clouds.

Units: Degrees latitude and longitude for geolocation, K for sub-pixel average temperature, m^2 for active fire area.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
40.6.4.1-1	1. At nadir	0.75 km	0.5 km
40.6.4.1-2	2. Worst case	1.6 km	0.5 km
40.6.4.1-3	b. Horizontal Reporting Interval	HCS	(TBD)
40.6.4.1-4	c. Horizontal Coverage	Land	Land
	d. Measurement Range:		
40.6.4.1-5	1. Sub-pixel average temperature of active fire	800 K – 1200 K	800 K – 1200 K
40.6.4.1-6	2. Sub-pixel area of active fire	from 1000 m^2 to 50 m times ground sample distance in scan direction (TBR)	from $(50\ m)^2$ to 100 m by greater of pixel in-scan and in-track dimensions (TBR).
	e. Measurement Uncertainty		
40.6.4.1-7	1. Sub-pixel average temperature of active fire	50 K	25 K
40.6.4.1-8	2. Sub-pixel area of active fire	30%	15%
40.6.4.1-9	f. Mapping Uncertainty	1.5 km	0.1 km
40.6.4.1-11	g. Maximum Local Average Revisit Time (S)	6 hrs	1 hour
40.6.4.1-12	h. Deleted.		
40.6.4.1-10	i. Deleted		
40.6.4.1-13	j. Latency (S)	90 minutes	15 minutes

40.7 Ocean/Water EDRs

40.7.1 Currents (DoD-Coastal; DOC-Surface) - DELETED

40.7.2 Fresh Water Ice - Moved to 40.7.8.1

40.7.3 Ice Surface Temperature

As a threshold, the temperature of the surface of ice over land or water is required. The objective is to measure the atmospheric temperature 2 m above the surface of the ice. This EDR is required under clear conditions only.
Units: K

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.7.3-1	1. Nadir	1.0 km	0.1 km
40.7.3-9	2. Worst case	1.6 km	0.1 km
40.7.3-2	b. Horizontal Reporting Interval	1.0 km	0.1 km
40.7.3-3	c. Horizontal Coverage	Ice-covered land/water	Ice-covered land/water
40.7.3-4	d. Measurement Range	213 K – 275 K	213 K - 293 K (2 m above ice)
40.7.3-5	e. Measurement Uncertainty	0.5 K	(TBD)
40.7.3-6	f. Mapping Uncertainty, nadir	0.4 km	0.1 km
40.7.3-7	g. Maximum Local Average Revisit Time (S)	24 hrs	12 hrs
40.7.3-8	h. Deleted.		
40.7.3-10	i. Latency (S)	90 minutes	15 minutes

40.7.4 Littoral Sediment Transport - DELETED

40.7.5 Net Heat Flux

Net heat flux refers to net surface flux over oceans (including ice covered). Components are long-wave and short-wave radiation, latent heat flux and sensible heat flux. The requirements below apply under clear conditions only.

Units: W/m^2

Para. No.		Threshold	Objectives
40.7.5-1	a. Horizontal Cell Size	20 km	5 km
40.7.5-2	b. Horizontal Reporting Interval	HCS	(TBD)
40.7.5-3	c. Horizontal Coverage	Oceans	Global Oceans
40.7.5-4	d. Measurement Range	0 - 2000 W/m^2	0 - 2000 W/m^2
40.7.5-5	e. Measurement Accuracy	10 W/m^2	1 W/m^2
40.7.5-6	f. Measurement Precision	25 W/m^2	1 W/m^2
40.7.5-7	g. Mapping Uncertainty	1.5 km	(TBD)
40.7.5-8	h. Maximum Local Average Revisit Time (S)	6 hrs	3 hrs
40.7.5-9	i. Deleted.		
40.7.5-10	j. Latency (S)	24 hours	6 hours

40.7.6 Ocean Color/Chlorophyll

Ocean color is defined as the spectrum of water-leaving radiances (L_w), i.e. the portion of the visible-near infrared light that is reflected at the surface. All geophysical quantities of interest, e.g., the concentration of phytoplankton pigment chlorophyll α (chlorophyll-α) and the inherent optical properties of absorption and scattering of surface waters (ocean optical properties), are derived from these L_w values. Water leaving radiances are measured in mW cm^{-2} μm^{-1} sr^{-1}. Ocean optical properties, absorption, and scattering are estimated at each measured visible wavelength, and have units of m^{-1} while chlorophyll-α is measured in mg m^{-3}. This EDR is required under clear, daytime conditions only.

Units:
Ocean Color : W m^{-2} μm^{-1} sr^{-1}
Ocean Optical Properties: m^{-1}
Chlorophyll: mg m^{-3}

Para. No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.7.6-1	1. Worst case	1.6 km	0.1 km
40.7.6-2	2. Nadir	0.75 km	0.1 km
40.7.6-3	b. Horizontal Reporting Interval	HCS	HCS
40.7.6.7-29	c. Horizontal Coverage	Oceans	Oceans
40.7.6-4	Deleted		
40.7.6-5	Deleted		
	d. Measurement Range		
40.7.6-13	1. Ocean Color	1.0-10 W m^{-2} μm^{-1} sr^{-1}	0.05-10 W m^{-2} μm^{-1} sr^{-1}
	2. Optical Properties		
40.7.6-14	a. Absorption	0.01 – 10 m^{-1}	0.005 – 20 m^{-1}
40.7.6-15	b. Scattering	0.01 – 50 m^{-1}	0.005 – 75 m^{-1}
40.7.6-16	c. Chlorophyll Fluorescence	N/A	Detectable signals in waters with chlorophyll from 0.1 to 50 mg m^{-3} at 1 km resolution.
40.7.6-6	3. Chlorophyll	0.05 – 50 mg/m^3	0.001 - 100 mg/m^3
	e. Measurement Accuracy		
	1. Ocean Color		
40.7.6-17	a. Operational	10 %	5 %
40.7.6-18	b. Deleted.		
	2. Optical Properties		
40.7.6-19	a. Operational	40 %	30 %
40.7.6-20	b. Deleted.		
	3. Chlorophyll		
40.7.6-7	a. Operational	15% Chl < 1.0 mg/m^3 30% 1.0 < Chl < 10 mg/m^3 50% Chl > 10 mg/m^3	20 %
40.7.6-21	b. Deleted.		
	f. Measurement Precision		
	1. Ocean Color		
40.7.6-22	a. Operational	5 %	2 %
40.7.6-23	b. Deleted.		
	2. Optical Properties		
40.7.6-24	a. Operational	20 %	20 %
40.7.6-25	b. Deleted.		

	3. Chlorophyll		
40.7.6-8	a. Operational	20% Chl < 1.0 mg/m^3 30% 1.0 < Chl < 10 mg/m^3 50% Chl > 10 mg/m^3	10 %
	g. Mapping Uncertainty		
40.7.6-9	1. Worst Case	0.8 km (intermediate swath)	0.1 km
40.7.6-10	2. Nadir	0.4 km	0.1 km
40.7.6-11	h. Max Local Average Revisit Time (S)	24 hrs	12 hrs
40.7.6-12	i. Deleted.		
40.7.6-26	j. Long Term Stability ($W\ m^{-2}\ \mu m^{-1}\ sr^{-1}$) (C) SEE NOTE 1	Max Chl Absorption 0.5 Min Chl Absorption 0.25 Atmospheric Correction 0.08	Max Chl Absorption 0.25 Min Chl Absorption 0.125 Atmospheric correction 0.04
	k. Latency (S)		
40.7.6-27	1. Operational	180 minutes	60 minutes
40.7.6-28	2. Deleted.		

Note 1: Stability is for water leaving radiance at the band of Maximum Chlorophyll absorption (measured at approximately 445 nm), Min Chlorophyll Absorption (at approximately 555 nm), and Atmospheric Correction (at approximately 865 nm).

40.7.7 Ocean Wave Characteristics – Significant Wave Height

Ocean wave characteristics are defined as the height of ocean waves expressed as significant wave height (i.e., the average height of the highest 1/3 of the waves in a horizontal cell) and direction of ocean waves. The requirements below apply under both clear and cloudy conditions. Refresh requirement is to provide observations along the satellite nadir-track of any satellite carrying an altimeter.

Units:
HEIGHT: M
Direction: Degrees from north

Para. No.		Thresholds	Objectives
40.7.7-1	a. Horizontal Cell Size, Nadir, along track	2.5 – 20 km (sea state dependent)	2.5 km
40.7.7-2	Deleted		
40.7.7-3	Deleted		
40.7.7-4	Deleted		
40.7.7-5	b. Horizontal Reporting Interval	(TBD)	(TBD)
40.7.7-6	c. Horizontal Coverage	Global, ice-free ocean and Great Lakes	Global, ice-free ocean and Great Lakes
	d. Measurement Range		
40.7.7-7	1. Height	0.1 - 30 m	0.0 - 30 m
40.7.7-8	2. Deleted		
	e. Measurement Accuracy		
40.7.7-9	1. Height	0.2 m	0.2 m
40.7.7-10	2. Deleted		
	f. Measurement Precision		
40.7.7-11	1. Height	0.2 m or 10%, whichever is greater	0.1 m or 10% whichever is greater
40.7.7-12	2. Deleted		
40.7.7-13	g. Mapping Uncertainty	2 km	0.25 km
40.7.7-14	Deleted		
40.7.7-15	h. Maximum Local Average Revisit Time	N/A	N/A
40.7.7-16	i. Deleted.		
40.7.7-17	j. Latency (S)	120 minutes	15 minutes

40.7.8 Sea Ice Characterization

Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice covered region of the ocean. The content of the sea ice age EDR is the typing of areas of sea ice by age. The requirements below apply under all weather conditions.

Units:
Ice age: WMO Nomenclature Class
Ice edge Concentration: Tenths

Para. No.		Threshold	Objectives
40.7.8-1	a. Horizontal Cell Size (Ice Age)		
	Clear	2.4 km	0.1 km
	All Weather	20 km	0.05 km
40.7.8-2	b. Horizontal Reporting Interval	HCS	HCS
40.7.8-3	c. Horizontal Coverage	Oceans	All ice covered regions of the global ocean
	d. Measurement Range		
40.7.8-4	1. Ice Age Classes	New/Young, First Year, Multi-year	Ice free, Nilas, GreyWhite, Grey, White, First Year Medium, First Year thick, Second Year, and Multiyear; Smooth and Deformed Ice
40.7.8-5	2. Ice Concentration	1/10 to 10/10	0/10 to 10/10
40.7.8-6	e. Probability of Correct Typing (Ice Age)	80% (First year from Multi-year) 70% (New/Young from First year) 70% (New/Young from Multi-year)	90 %
40.7.8-7	f. Measurement Uncertainty (Ice Concentration)	1/10	5 %
40.7.8-8	g. Mapping Uncertainty	1.5 km	0.05 km
40.7.8-9	h. Max Local Average Revisit Time (S)	24 hrs	6 hrs
40.7.8-10	i. Deleted.		
40.7.8-11	j. Long Term Stability (C)	1 % concentration	
40.7.8-12	k. Latency (S)	8 hrs	15 minutes

40.7.8.1 Fresh Water Ice (Application of Sea Ice Characterization)

Fresh water ice concentration is defined as the fraction of a specified area of fresh water that is covered by ice. Ice edge boundary is the contour separating fresh water from fresh water ice. The error in ice edge boundary location is defined as the distance between a measured boundary point and the nearest point on the true ice edge boundary. This product is required by OMPS for processing the Ozone EDR.

Para No.		Threshold	Objectives
	a. Horizontal Cell Size		
40.7.8.1-1	Nadir	0.8 km	(TBD)
40.7.8.1-2	Worst Case	3.2 km	4 times 0.65 km (TBR)
40.7.8.1-3	b. Horizontal Reporting Interval	HCS	HCS
40.7.8.1-4	c. Horizontal Coverage	Fresh water	Fresh water
40.7.8.1-5	d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration
	f. Measurement Uncertainty		
40.7.8.1-6	1. Ice edge Boundary	0.4 km Nadir 1.0 km EOS	5 km
40.7.8.1-7	2. Ice concentration	0.10	10%
40.7.8.1-8	g. Mapping Uncertainty	1.5 km	1 km
40.7.8.1-9	h. Max Local Average Revisit Time (S)	24 hrs	6 hrs
40.7.8.1-10	i. Latency (S)	90 minutes	15 minutes

40.7.9 Sea Surface Height

Sea surface height is defined as topography of the ocean surface with respect to the Earth's reference ellipsoid in a well-maintained terrestrial reference frame. Its variability is associated with mesoscale, basin scale, and global scale ocean phenomena. The requirements below apply under both clear and cloudy conditions.

Units: m

Para. No.		Thresholds	Objectives
40.7.9-1	a. Horizontal Cell Size (at nadir along track)	15 km	2 km
40.7.9-2	b. Horizontal Reporting Interval	1 km	0.2 km
40.7.9-3	c. Horizontal Coverage	66S to 66N latitude	85S to 85N latitude
40.7.9-4	d. Deleted		
	e. Measurement Accuracy		
40.7.9-5	1. Coastal/Mesoscale	6 cm	4 cm
40.7.9-11	2. Basin Scale	5 cm	3 cm
40.7.9-12	3. Global Scale	4 cm	2 cm
40.7.9-6	f. Measurement Precision	3 cm	2 cm
40.7.9-7	g. Deleted		
40.7.9-8	h. Deleted		
40.7.9-9	i. Deleted		
40.7.9-10	j. Closest Point to Shore	10 km	3 km
40.7.9-13	k. Exact Repeat Orbit	20 days	10 days
40.7.9-14	l. Equatorial Track Spacing	$\leq$ 165 km	$\leq$ 50 km
	m. Timeliness		
40.7.9-15	1. Coastal/Mesoscale	24 hr	3 hr
40.7.9-16	2. Basin Scale	3 days	2 days
40.7.9-17	3. Global Scale	3 months	2 months
40.7.9-18	n. Long Term Stability (C)	1 mm yr^{-1}	0.5 mm yr^{-1}
40.7.9-19	o. Ground cross track repeatability (S)	$\pm$ 1 km	
40.7.9-20	p. Station Keeping (S)	$\pm$ 10 min	

40.7.10 Global Sea Surface Wind Stress

Surface wind stress is defined as magnitude of the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves. Measurement range is to be consistent with the 3-25 m/s range as specified in the Sea Surface Winds EDR. The requirements below apply under both clear and cloudy conditions.

Units: N/m^2

Para. No.		Thresholds	Objectives
40.7.10-1	a. Horizontal Cell Size	20 km	1 km
40.7.10-2	b. Horizontal Reporting Interval	20 km	20 km
40.7.10-3	c. Horizontal Coverage	Oceans	Oceans
40.7.10-4	d. Measurement Range	0 – 2.2 N m^{-2}	0 - 10 N m^{-2}
40.7.10-5	e. Measurement Accuracy	0.02 N m^{-2}	0.01 N m^{-2}
40.7.10-6	f. Measurement Precision	0.02 N m^{-2}	0.01 N m^{-2}
40.7.10-7	g. Mapping Uncertainty	3 km	1 km
40.7.10-8	h. Maximum Local Average Revisit Time (S)	8 hrs	1 hr
40.7.10-9	i. Deleted.		
40.7.10-10	j. Latency (S)	90 minutes	15 minutes

40.7.11 Mass Loading (IORD Name: Turbidity) - DELETED

40.8 Space Environmental EDRs (TBR)

40.8.1 Auroral Boundary

The auroral boundaries are the loci of points representing the equatorward and poleward edges of the auroral zones. A more precise definition of these boundaries can only be formulated within the context of the measurement technique involved. The requirement is the specification of the *equatorward* auroral boundary presented as the set of geographic latitudes and longitudes for the boundary referenced to an altitude of 120 km. The specification of the *poleward* boundary of the auroral zone is left as an objective measurement.

Units: Degrees latitude and longitude at a reference altitude of 120 km

Para. No.	Parameter	Thresholds	Objectives
40.8.1-1	a. Horizontal Reporting Interval	50 km	10 km
40.8.1-2	b. Horizontal Coverage	>30° latitude, N/S	Global
40.8.1-3	c. Measurement Range	>30^{o} latitude, N/S	Global
40.8.1-4	d. Measurement Uncertainty	50 km	10 km
40.8.1-5	e. Reporting Frequency	Twice per orbit	Four times per orbit
40.8.1-6	f. Latency (S)	90 minutes	15 minutes

40.8.2 Auroral Energy Deposition

Auroral Energy Deposition refers to the energy flux into the ionosphere from precipitating auroral particles. These data are used to estimate the total auroral heat input into each hemisphere. The hemispheric power input can be determined from direct auroral particle measurements or auroral imagery. In-situ measurements of precipitating ion and electron fluxes may be combined with statistical models of auroral activity to provide an estimate of the hemispheric power input. The total heat input can also be derived from ultraviolet (UV) and / or X-ray auroral imagery. The requirement on the EDR is the set of measurements of the auroral heat flux along the satellite path in each hemisphere.

Units: Energy flux: W/m^2
Mean Energy: eV

Para. No.	Parameter	Thresholds	Objectives
	a. Measurement Range		
40.8.2-1	1. Energy Flux	10^{-4} – 1 W/m^2	5 x 10^{-5} – 1 W/m^2
40.8.2-7	2. Energy Range	100 eV to 20 KeV	30 eV to 50 KeV
40.8.2-2	b. Horizontal Spatial Resolution	100 km	10 km
40.8.2-3	c. Horizontal Coverage	>30^o latitude, N/S	Global
40.8.2-4	d. Measurement Uncertainty	Greater of{10^{-4} W/m^2, 10%}	Greater of{$5x10^{-5}$ W/m^2, 5%}
40.8.2-5	e. Deleted		
40.8.2-6	f. Deleted		
40.8.2-8	g. Latency (S)	90 minutes	15 minutes
40.8.2-9	h. Horizontal Reporting Interval	100 km	10 km

40.8.3 Auroral Imagery

Two-dimensional (horizontal) images of the Earth's auroral zones. Imagery can be obtained at a variety of wavelengths, including the near infrared (IR), visible (VIS), ultraviolet (UV), and X-ray.

Units:
DMSP auroral activity criteria

Para. No.	Parameter	Thresholds	Objectives
40.8.3-1	a. Horizontal Cell Size	25 km	10 km
40.8.3-2	b. Horizontal Reporting Interval	25 km	10 km
40.8.3-3	c. Horizontal Coverage	>30^o latitude, N/S	Global
40.8.3-4	d. Measurement Range	2.5 – 50 ergs cm^{-2} sec^{-1}	0.25 – 50 ergs cm^{-2} sec^{-1}
40.8.3-5	e. Measurement Uncertainty	10%	5%
40.8.3-6	f. Mapping Uncertainty	10 km	1 km
40.8.3-7	g. Maximum Local Average Revisit Time (S)	4 hours	15 minutes
40.8.3-8	h. Latency (S)	90 minutes	15 minutes

40.8.4 Electric Field

An in-situ measure of the ambient electric field (quasi DC). Electric fields can be measured directly using electric field booms or inferred from associated measurements of convection. The requirement on the EDR is the set of measurements of the electric field vector along the satellite path in each hemisphere.

Units: mV/m (millivolts per meter)

Para. No.	PARAMETER	Thresholds	Objectives
40.8.4-1	a. Measurement Range	0 to ±150 mV m^{-1}	0 to ±250 mV m^{-1}
40.8.4-2	b. Horizontal Cell Size	10 km	1 km
40.8.4-3	b. Horizontal Reporting Interval	10 km	1 km
40.8.4-4	c. Horizontal Coverage	Global	Global
40.8.4-5	d. Measurement Uncertainty	3.0 mV m^{-1}	0.1 mV m^{-1}
40.8.4-6	e. Measurement Precision	2.0 mV m^{-1}	0.1 mV m^{-1}
40.8.4-7	f. Deleted		
40.8.4-8	g. Latency (S)	90 minutes	15 minutes

40.8.5 Electron Density Profile

A measure of the electron density profile (EDP) and the total electron content (TEC) of the ionosphere. The ionosphere extends from; 1) the lower D near 60 km, 2) up through the local E-region and F_2-region peaks closer to 100 km and 250 km, respectively, 3) into the topside ionosphere, and 4) stretching up to the inner edge of the plasmasphere near 3000 km. The density along the EDP typically reaches a maximum at the F_2 peak The requirement on this EDR is for the EDP within the primary range of interest; that is, between 90 km and satellite altitude Unless otherwise indicated, the vertical TEC is associated with the ionospheric column content; that is, from the ground to 36,000 km altitude.

A variety of techniques exist for measuring the ionospheric EDP. Included are in-situ measurements of plasma parameters such as density and temperature (see EDR 40.8.10), optical remote sensing techniques such as auroral imagery (EDR 40.8.3) and atmospheric airglow, active and passive high-frequency remote sensing, and TEC measurements using GPS. The following is a partial list of useful ionospheric features which may be measured or inferred:

Features	Units	Definition
n_mF_2	cm^{-3}	Density at the F_2 peak
h_mF_2	km	Altitude of the F_2 peak
n_mE	cm^{-3}	Density at the E peak
h_mE	km	Altitude of the E peak
λ_{height}	km	Scale height for the topside ionosphere
h_{trans}	km	Transition height for dominance of OII to light ions
$n_{in\text{-}situ}$	cm^{-3}	Density measured at the NPOESS spacecraft
$TEC_{overhead}$	cm^{-2}	TEC above NPOESS

Units:
cm^{-3} (density)
km (height)
TECU (1 TECU=10^{16} m^2)

Para. No.		Thresholds	Objectives
	a. Measurement Range		
40.8.5-1	1. Density, n_e	$2.5x10^4 – 10^7$ cm^{-3}	$10^4 – 10^7$ cm^{-3}
40.8.5-2	2. TEC (vertical)	3 – 200 TEC units	1 – 200 TEC units
	3. Features		
40.8.5-3	n_mF_2	10^5 - 10^7 cm^{-3}	10^4 - 10^7 cm^{-3}
40.8.5-4	h_mF_2	150 - 700 km	150 - 800 km
40.8.5-5	n_mE	10^5 - 10^7 cm^{-3}	10^4 - 10^7 cm^{-3}
40.8.5-6	h_mE	90-150 km	90 - 150 km
40.8.5-7	λ_{height}	N/A	[*TBD*]
40.8.5-8	h_{trans}	N/A	[*TBD*]
40.8.5-9	$n_{in\text{-}situ}$	$5x10^3 – 5x10^6$ cm^{-3}	10^2 - 10^7 cm^{-3}
40.8.5-10	$TEC_{overhead}$	N/A	[*TBD*]
40.8.5-11	Ion composition	N/A	O_2^+, NO^+, O^+, H^+, He^+
40.8.5-12	b. Horizontal Coverage	Global	Global
40.8.5-13	c. Vertical Coverage	90 km to Satellite Altitude	90 to 3000 km
	d. Horizontal Cell Size		
40.8.5-14	1. Latitudes: 0-30°	100 km	10 km
40.8.5-15	2. Latitudes: 30-90°	50 km	10 km
40.8.5-16	3. Deleted		
	e. Vertical Cell Size (EDP)		
40.8.5-17	1. 90 to 500 km	10 km	3 km
40.8.5-18	2. above 500 km	20 km	5 km
40.8.5-19	f. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
40.8.5-20	g. Vertical Reporting Interval (EDP)	Vertical Cell Size	Vertical Cell Size
	h. Measurement Uncertainty		
40.8.5-21	1. Density, n_e	Greater of {10^5 cm^{-3}, 30%}	Greater of {10^4 cm^{-3}, 5%}
40.8.5-22	2. TEC (vertical)	Greater of {3 TEC units,	Greater of {1 TEC unit,

		30%}	30%}
	3. Features		
40.8.5-23	n_mF_2	20%	10%
40.8.5-24	h_mF_2	20 km	5 km
40.8.5-25	n_mE	20%	5%
40.8.5-26	h_mE	10 km	3 km
40.8.5-27	λ_{height}	N/A	[*TBD*]
40.8.5-28	h_{trans}	N/A	[*TBD*]
40.8.5-29	$n_{In\text{-}situ}$	Greater of $\{10^4\ cm^{-3}$ or 20%}	Greater of $\{2x10^2\ cm^{-3}$ or 5%}
40.8.5-30	$TEC_{Overhead}$	N/A	[TBD]
40.8.5-31	Ion composition	N/A	5% of local density, n_e
40.8.5-32	i. Latency (S)	90 minutes	15 minutes

40.8.6 Geomagnetic Field

In-situ measurements of the geomagnetic field. The primary use of this data is to support the periodic (5-year) updates to the World Magnetic Model (WMM), Mil-W-89500. The needs of the WMM require a well calibrated vector magnetometer over the duration of the mission.
Units: nanotesla (nT)

Para. No.	Parameters	Thresholds	Objectives
40.8.6-1	a. Measurement Range (per axis)	0 to ±60,000 nT	0 to + 60,000 nT
40.8.6-2	b. Measurement Accuracy (per axis)	5 nT	2 nT
40.8.6-3	c. Measurement Precision (per axis)	30 nT	30 nT
40.8.6-4	d. Deleted		
40.8.6-5	e. Horizontal Cell Size	100 m	100 m
40.8.6-6	f. Horizontal Coverage	Global	Global
40.8.6-7	g. Horizontal Reporting Interval	1 km	0.1 km
	h. Deleted		
40.8.6-8	1. Deleted		
40.8.6-9	2. Deleted		
40.8.6-10	i. Latency (S)	90 minutes	15 minutes

40.8.7 In-situ Ion Drift Velocity - DELETED

40.8.8 In-situ Plasma Density - DELETED

40.8.9 In-situ Plasma Fluctuations

In-situ measurement of plasma density fluctuations. The desired products are: 1) the mean plasma density; 2) the scale-sizes for ionospheric density structures; 3) the RMS value of δn/n, and 4) the spectral index for the fluctuation spectrum.

Units:
Mean Plasma Density: cm^{-3}
Fluctuation Scale Length: m
Spectral Index: Dimensionless
δn/n: Dimensionless

Para. No.	Parameter	Thresholds	Objectives
40.8.9-1	a. Horizontal Reporting Interval	50 km	10 km
40.8.9-2	b. Horizontal Coverage	Global	Global
	c. Measurement Range		
40.8.9-3	1. Mean Plasma Density	$5x10^3$ to $5x10^6$ cm^{-3}	10^2 to 10^7 cm^{-3}
40.8.9-4	2. Fluctuation Scale Length	5 to 10^4 m	5 to 10^4 m
40.8.9-5	3. Spectral Index	1 to 5	1 to 5
40.8.9-6	4. δn/n	10^{-2} to 1	10^{-2} to 1
	d. Measurement Uncertainty		
40.8.9-7	1. Mean Plasma Density	Greater of {20%, $5x10^3$ cm^{-3}}	Greater of {5%, $2x10^2$ cm^{-3}}
40.8.9-8	2. Deleted		
	e. Measurement Precision		
40.8.9-9	1. Spectral Index	0.2	0.1
40.8.9-10	2. δn/n	10^{-2}	10^{-2}
40.8.9-11	f. Deleted		
40.8.9-12	g. Latency (S)	90 minutes	15 minutes

40.8.10 In-situ Plasma Temperature - T_e and T_i

In-situ measurements of the electron and ion temperatures. Temperatures are used to determine topside scale heights as inputs to future operational ionospheric specification models.

Units: Degrees Kelvin (K)

Para. No.	Parameter	Thresholds	Objectives
40.8.10-1	a. Horizontal Reporting Interval	HCS	HCS
40.8.10-2	b. Horizontal Coverage	Global	Global
40.8.10-3	c. Measurement Range	500 - 10,000 K	500 to 10,000 K
40.8.10-4	d. Measurement Uncertainty	10 %	5 %
40.8.10-5	e. Latency (S)	90 minutes	15 minutes
	f. Horizontal Cell Size		
40.8.10-6	1. Latitudes 0-30° N/S	100 km	10 km
40.8.10-7	2. Latitudes 30-90 ° N/S	50 km	10 km

40.8.11 Ionospheric Scintillation

Ionospheric scintillation, which manifests itself as increased noise on a radiowave signal intensity and phase, is caused by small-scale variations in the ionospheric electron density along a trans-ionospheric propagation path between a transmitter and a receiver (after NWRA). The magnitude of the effect depends on the ionospheric background, the amplitude and spectral characteristics of ionospheric density fluctuations and the frequency of the radiowave transmission. Maximum scintillation effects are expected 1) at low magnetic latitudes after sunset and 2) within the auroral zones and polar caps. The requirement is for direct measure of scintillation parameters in terms of amplitude and phase fluctuation indices S_4 and sigma-ø at VHF to S-band frequencies. These data will be used for a global specification of scintillation.

Units:
S_4: Dimensionless
sigma-ø: radians

Para. No.	Parameter	Thresholds	Objectives
40.8.11-1	a. Horizontal Cell Size	50 km	10 km
40.8.11-2	b. Horizontal Coverage	Global	Global
	c. Measurement Range		
40.8.11-3	1. S_4	0.1 - 1.5	0.1 to 1.5
40.8.11-4	2. sigma-ø	0.1 - 20 radians	0.1 to 20 radians
	d. Measurement Uncertainty		
40.8.11-5	1. S_4	0.1	0.1
40.8.11-6	2. sigma-ø	0.1 radian	0.1 radians
40.8.11-7	e. Local Time Range	All Local Times	All Local Times
40.8.11-8	f. Latency (S)	90 minutes	15 minutes

40.8.12 Neutral Density Profile

Measurement of neutral density profiles. Profiles are to be used, along with other geophysical quantities, as inputs to upper atmospheric density models.

Units:
Atmospheric density: g cm^{-3}
Number Density: cm^{-3}

Para. No.	Parameter	Thresholds	Objectives
40.8.12-1	a. Horizontal Cell Size	500 km	250 km
40.8.12-2	b. Horizontal Reporting Interval	500 km	250 km
	c. Vertical Cell Size		
40.8.12-3	1. Up to 120 km	5 km	0.5 km
40.8.12-4	2. Above 120 km	5 km	3 km
	d. Vertical Reporting Interval		
40.8.12-5	1. <120 km	5 km	2.5 km
40.8.12-16	2. 120 to 200 km	10 km	5 km
40.8.12-17	3. >200 km	30 km	15 km
40.8.12-6	e. Horizontal Coverage	Global	Global
40.8.12-7	f. Vertical Coverage	90 km to Satellite Altitude	90 to 1600 km
	g. Measurement Range		
40.8.12-8	1. Atmospheric density	$8.5x10^{-18}$ to $5x10^{-9}$ g cm^{-3}	$2x10^{-19}$ to $5x10^{-9}$ g cm^{-3}
40.8.12-9	2. Number density	10^{6} to $6x10^{13}$ cm^{-3}	$9x10^{4}$ to $6x10^{13}$ cm^{-3}
40.8.12-10	3. Neutral composition – in-situ	N/A	N_2, O_2, O, He, H
	h. Measurement Uncertainty (Density)		
40.8.12-11	1. 90 to 500 km	10%	5%
40.8.12-12	2. 500 to 700 km	15%	10%
40.8.12-13	3. 700 to 800 km	20%	
40.8.12-18	4. 700 to 1600 km		15%
40.8.12-14	i. Measurement Precision	5%	1%
40.8.12-15	j. Latency (S)	90 minutes	15 minutes
	k. Altitude Registration		
40.8.12-19	1. 90 to 500 km	1 km	0.5 km
40.8.12-20	2. 500 to 700 km	1.5 km	1 km
40.8.12-21	3. 700 to 800 km	2 km	
40.8.12-22	4. 700 to 1600 km		1.5 km

40.8.13 Medium Energy Charged Particles

Measurements of particles in this energy range are required to serve as inputs to models of the auroral ionosphere, determine the boundaries and extent of the polar cap, and provide inputs to magnetospheric models. These data are also used in the analysis of satellite anomalies involving surface charging and, at the higher energies, deep-dielectric charging and radiation damage. The requirement is for the energy distribution of both ions and electrons within the specified energy ranges. Particle measurements are required over a range of pitch angles both inside and external to the local loss cone.

Units:
Energy: keV or MeV
Flux: $m^{-2}sec^{-1}sr^{-1}$

Para. No.	Parameter	Thresholds	Objectives
40.8.13-1	a. Horizontal Reporting Interval	25 km	10 km
	b. Measurement Range		
40.8.13-2	1. Energy - ions	50 keV to 10 MeV	50 keV to 10 MeV
40.8.13-13	2. Energy - electrons	50 keV to 4 MeV	50 keV to 4 MeV
40.8.13-3	3. Total flux	10^6 to $5x10^{11}$ m^{-2} s^{-1} sr^{-1}	$5x10^5$ to $2x10^{12}$ m^{-2} s^{-1} sr^{-1}
40.8.13-4	4. Sensor FOV	0^o and 90^o (two angles)	0^o and 90^o (multiple angles)
40.8.13-16	5. Energy Resolution (p^+)	6 logarithmically spaced bands	8 logarithmically spaced bands
40.8.13-17	6. Energy Resolution (e^-)	5 logarithmically spaced bands	6 logarithmically spaced bands
	c. Measurement Precision		
40.8.13-5	1. Deleted		
40.8.13-6	2. Total flux	Greater of {10^6 m^{-2} s^{-1} sr^{-1}, 5%}	Greater of {10^5 m^{-2} s^{-1} sr^{-1}, 1%}
40.8.13-7	3. Sensor FOV	$\leq 30^o$	$\leq 20^o$
	d. Measurement Uncertainty		
40.8.13-8	1. Energy	10%	5%
40.8.13-9	2. Deleted		
40.8.13-10	3. Deleted		
	e. Total Dose		
40.8.13-11	1. Range	N/A	10^1 to 10^6 rads/yr
40.8.13-12	2. Moderator Range	N/A	4, 100, 250, 500 mils Al
	f. Measurement Accuracy		
40.8.13-14	1. Total Flux	15%	10%
40.8.13-18	2. Sensor FOV	$\leq 3^o$	$\leq 2^o$
40.8.13-15	g. Latency (S)	90 minutes	15 minutes

40.8.14 Energetic Ions

Definition:
Measurements of energetic ions within this energy range required as input to models of the auroral ionosphere, especially D-region and to determine the polar cap boundary. These data are also used in assessments of satellite anomalies, semiconductor and solar-cell radiation damage, and radiation hazard to astronauts and aircraft personnel. The requirement is a measurement of the ion characteristics, including the energy spectrum and particle pitch angle.

Units:
Energy: MeV
Flux: $m^{-2}sec^{-1}sr^{-1}$

Para. No.	Parameter	Thresholds	Objectives
40.8.14-1	a. Horizontal Cell Size	25 km	25 km
40.8.14-2	b. Horizontal Coverage	>30° Latitude, N/S	>30° Latitude, N/S
	c. Measurement Range		
40.8.14-3	1. Energy (p^+)	10 MeV to 300 MeV	10 MeV to 400 MeV
	2. Flux – protons		
40.8.14-4	A. P^+ < 100 MEV	$5x10^3 – 2x10^9$ m^{-2} s^{-1} sr^{-1}	$5x10^3 – 2x10^9$ m^{-2} s^{-1} sr^{-1}
40.8.14-13	B. P^+ > 100 MEV	$10^3 – 3x10^8$ m^{-2} s^{-1} $ster^{-1}$	$10^3 – 3x10^8$ m^{-2} s^{-1} $ster^{-1}$
40.8.14-5	3. Flux – alphas	N/A	$10^2 – 10^8$ m^{-2} s^{-1} $ster^{-1}$
40.8.14-6	4. Sensor Viewing Angle	0°	0°
40.8.14-14	5. Linear Energy transfer (Heavy Ions)		0.1 to 100 MeV cm^2 mg^{-1}
40.8.14-19	6. Energy Resolution	4 logarithmically spaced bands	5 logarithmically spaced bands
	d. Measurement Precision		
40.8.14-7	1. Deleted		
	2. Flux - protons		
40.8.14-8	a. p^+ < 100 MeV	Greater of {$5x10^3$ m^{-2} s^{-1} $ster^{-1}$ or 5%}	Greater of {$5x10^3$ m^{-2} s^{-1} $ster^{-1}$ or 1 %}
40.8.14-15	b. p^+ > 100 MeV	Greater of {10^3 m^{-2} s^{-1} $ster^{-1}$ or 10 %}	GREATER OF {10^3 M^{-2} S^{-1} $STER^{-1}$ OR 2 %}
	3. FOV		
40.8.14-9	a. p^+ < 100 MeV	< 120° full angle	< 120° full angle
40.8.14-20	b. Deleted		
	e. Measurement Accuracy		
40.8.14-10	1. Deleted		
	2. Flux		
40.8.14-11	a. p^+ < 100 MeV	Greater of {$5x10^3$ m^{-2} s^{-1} $ster^{-1}$ or 20 %}	Greater of {$5x10^3$ m^{-2} s^{-1} $ster^{-1}$ or 10 %}
40.8.14-16	b. p^+ > 100 MeV	Greater of {10^3 m^{-2} s^{-1} $ster^{-1}$ or 10 %}	Greater of {10^3 m^{-2} s^{-1} $ster^{-1}$ or 2 %}
	3. FOV		
40.8.14-12	a. p^+ < 100 MeV	< 12°	< 8°
40.8.14-21	b. p^+ > 100 MeV	N/A (isotropic)	N/A (isotropic)
	f. Deleted		
40.8.14-17	1. Deleted		
40.8.14-18	g. Latency (S)	90 minutes	15 minutes
40.8.14-22	h. Measurement Uncertainty – Energy	20%	10%

40.8.15 Solar Extreme Ultraviolet Flux - DELETED

40.8.16 Supra-Thermal through Auroral Particles

In-situ measurements of moderately energetic (< 50 keV) electrons and ions, primarily in the auroral regions. These measurements are input to space environment models and are useful to satellite anomaly assessments (surface charging). The requirement is for the energy distribution and pitch angle distribution of precipitating charged particles within the specified energy range. Pitch angle information must be from within and external to the local loss cone angle.

Units:
Energy: eV or keV
Flux: $m^{-2}sec^{-1}sr^{-1}$
Pitch Angle: Degrees

Para. No.	Parameter	Thresholds	Objectives
40.8.16-1	a. Horizontal Reporting Interval	10 km	5 km
40.8.16-2	b. Horizontal Coverage	>30° Latitude, N/S	>30° Latitude, N/S
	c. Measurement Range (electrons and ions)		
40.8.16-3	1. Particle Energy	30 eV - 50 keV	30 eV – 50 keV
	2. Flux		
40.8.16-4	a. Electrons	10^9 - 10^{14} m^{-2} s^{-1} sr^{-1}	10^9 - 10^{14} m^{-2} s^{-1} sr^{-1}
40.8.16-15	b. Ions	10^9 - 10^{13} m^{-2} s^{-1} sr^{-1}	10^8 - 10^{13} m^{-2} s^{-1} sr^{-1}
40.8.16-5	3. Sensor Viewing Angles	0° & 90° (2 angles)	0° – 90° (multiple angles)
40.8.16-16	4. Particle Energy Resolution	24 log-periodic energy bands	32 log-periodic energy bands
	d. Measurement Precision		
40.8.16-6	1. Deleted		
40.8.16-7	2. Diff. Direct Energy Flux	Greater of {10^9 m^{-2} s^{-1} sr^{-1} or 10%}	Greater of {10^8 m^{-2} s^{-1} sr^{-1} or 2%}
40.8.16-8	3. Sensor FOV	<15°	<15%
	e. Measurement Accuracy		
40.8.16-9	1. Pass band Center Energy	2%	1%
40.8.16-10	2. Diff Dir Energy Flux	Greater of {10^9 $m^{-2}sec^{-1}$ sr^{-1} or 15%}	Greater of {10^9 $m^{-2}sec^{-1}$ sr^{-1} or 15%}
40.8.16-11	3. Sensor FOV	<3°	<3°
40.8.16-12	f. Measurement Uncertainty, Particle Energy	20%	15%
	g. Deleted		
40.8.16-13	1. Deleted		
40.8.16-14	2. Deleted		
40.8.16-17	h. Latency (S)	90 minutes	15 minutes

40.8.17 Upper Atmospheric Airglow - DELETED

40.8.18 Neutral Winds - (Moved to P3I)

40.9 Notes on Space Environmental EDRs - DELETED

41.1 RDR Requirements

TRD41.1-1
All RDRs and satellite data (e.g., ephemeris, time, attitude, etc.) required to process RDRs into EDRs shall be provided to the Centrals, Field Terminals (DoD and Civil) as specified in Appendix E, and archive.

TRD41.1-2
The content and format of the operational RDRs shall be documented in a Unique Interface Document (TBD).

41.1.1 CrIS RDRs

41.1.1.1 CrIS Data

TRD41.1.1.1-1
The data listed in 41.1.1.2 and its subparagraphs should be provided in the delivered CrIS RDRs.

41.1.1.2 RDR Content and Format

TRD41.1.1.2-1
The operational RDR should, at a minimum, consist of CCSDS encoded interferograms, telemetry, and calibration data packets.

41.1.1.2.1 Interferogram RDR Packets

TRD41.1.1.2.1-1
Interferogram CCSDS data packets should be created for each CrIS detector in each band and in each FOV. There are 27 such CCSDS data packets for each CrIS FOR.

TRD41.1.1.2.1-2
Each interferogram data packet should at a minimum contain the following information:

- One filtered/decimated/bit trimmed complex interferogram from a single CrIS detector having sample number, word width and bit trimming;
  - Band designator (LW, MW, SW);
  - Interferogram ZPD amplitude;
  - Spacecraft ID tag (0-31);
  - CrIS sensor ID or serial number (0-31);
  - Orbit number (0-65535);
  - Scan number within an orbit (0-1023);
  - FOR index (0-31); FOV number (1-9);
  - Interferometer sweep direction (+, -);
  - UTC stamp (start of interferometer sweep, ± 1 msec);
  - ZPD count position;
  - Fringe count error flag;
  - Fail bit trim flag;
  - Impulse noise count (0-127);
  - Invalid interferogram data (SEU, failed detector) flag.

41.1.1.2.2 Telemetry RDR Packets

TRD41.1.1.2.2-1
The average period between transmittals of CrIS Sensor CCSDS telemetry packets should be 200 milliseconds.

TRD41.1.1.2.2-2
The content of the CrIS sensor telemetry packet should consist of housekeeping and diagnostic data necessary to monitor the health, safety, command, and control of the CrIS sensor.

TRD41.1.1.2.2-3
When in diagnostic operating mode, up to eight channels of the high rate telemetry should be transmitted.

41.1.1.2.3 Calibration RDR Packets

TRD41.1.1.2.3-1
Calibration RDR packet(s) should be transmitted once every eight seconds.

TRD41.1.1.2.3-2
The calibration RDR packets should consist of all CrIS sensor unique data needed by SDR algorithms to convert RDR interferograms into geolocated, spectrally and radiometrically calibrated SDRs.

TRD41.1.1.2.3-3
The content of each calibration RDR packet should, at a minimum, contain the following: ICT temperatures; Optical component temperature telemetry; ICT emissivity model parameters; Electronic calibration (Dual A/D converter characterization); 8 spacecraft position samples x, y, z (<25 meter quantization); 8 spacecraft roll, pitch yaw samples (<10 mrad quantization); 8 time stamps for spacecraft position, roll, pitch, yaw samples (± 1 ms); ILS model parameters for each CrIS detector; CrIS mounting angles; Cross-track and In-track scan pointing error for each of the 30 earth scenes; Neon calibration signal count and time stamp; Laser diode temperature, voltage, and current.

TRD41.1.1.2.3-4
A collection of calibration data packets transmitted over a 4-minute period should comprise a complete data set used to produce calibrated SDR's.

41.1.2 OMPS RDRs

41.1.2.1 OMPS Data

TRD41.1.2.1-1
The data listed in 41.1.2.2, 41.1.2.3, 41.1.2.4 and their subparagraphs should be provided in the delivered OMPS RDRs.

41.1.2.2 OMPS Limb Profile RDR Content

TRD41.1.2.2-1
The limb sensor should provide vertical and wavelength dependent radiances from three different limb, along-track scenes, every 38 seconds.

TRD41.1.2.2-2
The following header information should be included in every limb RDR:

- RDR identification tag
- Spacecraft identification tag
- Sensor identification tag
- Flight software version numbers
- Ephemeris from spacecraft: 2-line element
- Julian date and time tag from spacecraft at the Ascending Node
- Sensor clock at the time of the Ascending Node
- Calibration identification code
- Sensor housekeeping data
- Julian date and time of data transmission
- Orbit Number
- Operation mode
- Data format code
- Date and time or spacecraft clock at start of frame
- Attitude error from spacecraft – at least one per frame
- Sensor status bits
- Check sums for all appropriate RDR subsets
- Raw sensor counts

41.1.2.3 OMPS Nadir Total Column RDR Content

TRD41.1.2.3-1
The nadir sensor should provide cross-track and wavelength dependent radiances from 35 equal angle cells every 7.6 seconds (nominally).

TRD41.1.2.3.1-2
The following header information should be included in an operational OMPS RDR at least once every 38 seconds:

- RDR identification tag
- Spacecraft identification tag
- Sensor identification tag
- Flight software version numbers
- Ephemeris from spacecraft: 2-line element
- Julian date and time tag from spacecraft at the Ascending Node
- Sensor clock at the time of the Ascending Node
- Calibration identification code
- Sensor housekeeping data
- Julian date and time of data transmission
- Orbit Number
- Operation mode
- DATA FORMAT CODE
- Date and time or spacecraft clock at start of frame

- Attitude error from spacecraft – at least one per frame
- Sensor status bits
- Check sums for all appropriate RDR subsets
- Raw sensor counts

41.1.2.4 OMPS Nadir Profile RDR Content

TRD41.1.2.4-1
The nadir sensor should provide wavelength dependent radiances from a single nadir scene every 38 seconds.

TRD41.1.2.4-2
The following information should be included in a nadir profile RDR every 38 seconds:

- RDR identification tag
- Spacecraft identification tag
- Sensor identification tag
- Flight software version numbers
- Ephemeris from spacecraft: 2-line element
- Julian date and time tag from spacecraft at the Ascending Node
- Sensor clock at the time of the Ascending Node
- Calibration identification code
- Sensor housekeeping data
- Julian date and time of data transmission
- Orbit Number
- Operation mode
- Data format code
- Date and time or spacecraft clock at start of frame
- Attitude error from spacecraft – at least one per frame
- Sensor status bits
- Check sums for all appropriate RDR subsets
- Raw sensor counts

41.1.3 CMIS RDRs [TBS]

41.1.4 VIIRS RDRs

TRD41.1.4-1
The VIIRS Sensor shall generate RDRs having the following data elements:

a. Band data from a single scan of Earth View scene
b. Calibration data from a single scan of all Calibration View scenes
c. Stream type (HRD or LRD)
d. Spacecraft ID
e. VIIRS Sensor ID
f. VIIRS Sensor mode
g. Scan count
h. Scan start and stop times
i. Spacecraft ephemeris
j. Encoder timing stability
k. FPA offsets
l. Calibration source temperatures, FPA temperatures, and Optics temperatures
m. Band identification, view identification, and compression type within the data stream

TRD41.1.4-2
While in Operational Mode, the VIIRS sensor shall append the following data elements to an RDR at least every two seconds:

a. Flight software checksum
b. Spacecraft related data necessary for geolocation (from Spacecraft)
c. Data acquisition orbit number (from Spacecraft)
d. Ascending Node Julian date and time tag (from Spacecraft)

41.1.5 GPSOS RDRs [TBS]

APPENDIX E

NPOESS Data Products

50.1 NPOESS Data Products.

The high rate data (HRD) downlink will contain all of the NPOESS sensor data and all of the NPOESS satellite data needed to meet the EDR processing requirements in Table 50.1.1. The numbers in the first column of Table 50.1.1 provide the Appendix D paragraph reference.

[Not applicable to NPP] The low rate data (LRD) downlink will contain a subset (TBR) of the NPOESS sensor data and all of the associated NPOESS satellite and ancillary data needed to meet the EDR processing requirements in Table 50.1.2. The numbers in the first column of Table 50.1.2 indicate the priority order for the minimum set of LRD EDRs.

[Not applicable to NPP] ADCS data will be contained in the HRD downlink. Search and Rescue telemetry data will be available from the SMD downlink.

TABLE 50.1.1

NPOESS CENTRAL AND HRD DATA PRODUCTS

Data Products	Central Requirements	HRD Requirements
40.2 Key Data Products		
40.2.1 Atmospheric Vertical Moisture Profile (AVMP)	X	X
40.2.2 Atmospheric Vertical Temperature Profile (AVTP)	X	X
40.2.3 Imagery	X	X
40.2.4 Sea Surface Temperature (SST)	X	X
40.2.5 Sea Surface Winds (Speed and Direction)	X	X
40.2.6 Soil Moisture	X	X
40.3 Atmospheric Data Products		
40.3.1.1 Aerosol Optical Thickness	X	X
40.3.1.2 Aerosol Particle Size Parameter	X	X
40.3.1.3 Suspended Matter	X	X
40.3.1.4 Aerosol Refractive Index, Single-Scattering Albedo, and Shape	X	X
40.3.2 Ozone Total Column/Profile	X	X
40.3.3 Precipitable Water	X	X
40.3.4 Precipitation (Type, Rate)	X	X
40.3.5 Pressure Profile	X	X
40.3.6 Total Water Content	X	X
40.4 Cloud Data Products		
40.4.1 Cloud Base Height	X	X
40.4.2 Cloud Cover/Layers	X	X
40.4.3 Cloud Effective Particle Size	X	X
40.4.4 Cloud Ice Water Path	X	X
40.4.5 Cloud Liquid Water	X	X
40.4.6 Cloud Optical Thickness	X	X
40.4.7 Cloud Top Height	X	X
40.4.8 Cloud Top Pressure	X	X
40.4.9 Cloud Top Temperature	X	X
40.4.10 Cloud Particle Size Distribution	X	X
40.5 Earth Radiation Budget Data Products		
40.5.1 Net Solar Radiation (ToA)	X	
40.5.2 Albedo (Surface)	X	X
40.5.3 Downward Long-wave Radiation (Surface)	X	
40.5.4 Downward Short-wave Radiation (Surface)	X	
40.5.5 Outgoing Long-wave Radiation (ToA)	X	
40.5.6 Solar Irradiance	X	
40.6 Land Data Products		

40.6.1 Land Surface Temperature	X	X
40.6.2 Vegetation Index	X	X
40.6.3 Snow Cover/Depth	X	X
40.6.4 Surface Type	X	X
40.6.4.1 Active Fires (Application of Surface Type EDR)	X	X
40.7 Ocean/Water Data Products		
40.7.3 Ice Surface Temperature	X	X
40.7.5 Net Heat Flux	X	X
40.7.6 Ocean Color/Chlorophyll	X	X
40.7.7 Ocean Wave Characteristics – Significant Wave Height	X	X
40.7.8 Sea Ice Characterization	X	X
40.7.8.1 Fresh Water Ice (Application of Sea Ice Characterization)		
40.7.9 Sea Surface Height	X	X
40.7.10 Global Sea Surface Wind Stress	X	X
40.8 Space Environmental Data Products (TBR)		
40.8.1 Auroral Boundary	X	X
40.8.2 Auroral Energy Deposition	X	X
40.8.3 Auroral Imagery	X	X
40.8.4 Electric Field	X	X
40.8.5 Electron Density Profile	X	X
40.8.6 Geomagnetic Field	X	X
40.8.9 In-situ Plasma Fluctuations	X	X
40.8.10 In-situ Plasma Temperature - T_e and T_i	X	X
40.8.11 Ionospheric Scintillation	X	X
40.8.12 Neutral Density Profile	X	X
40.8.13 Medium Energy Charged Particles	X	X
40.8.14 Energetic Ions	X	X
40.8.16 Supra-Thermal through Auroral Particles	X	X

TABLE 50.1.2

NPOESS LRD DATA PRODUCTS

High Priority EDRs, In Priority Order from Highest to Lowest	
1	Imagery Threshold Attributes: ▪ 0.8 km horizontal spatial resolution (HSR) worst case across scan for at least one visible and one IR band. ▪ Day/night band at night with 2.7 km HSR ▪ Provide Day and Night capability for the Field Terminal User** to: - Interpret High, Mid, and Low Cloud Types - Detect all Fog Types (Valley, Coast, etc.) - Distinguish Between Snow & Clouds - Detect Coastal Water Mass Features (coastal fronts, eddies, river plumes, etc.) - Detect Dust/Aerosol/Haze/Smoke ** The users intend to primarily exploit the LRD Imagery by manual methods (Interpretation, Detection, and Distinction) of inspection of processed images. When interpreting images, edge effects are important and may influence the algorithm processing the contractor chooses to implement for the Imagery EDR.
2	Atmospheric Vertical Temperature Profile (Surface to 100 mb only) Measurement Accuracy Threshold Attributes: ▪ Surface to 700 mb: 2.5K/1 km ▪ 700 mb to 300 mb: 1.5 K/1 km ▪ 300 mb to 100 mb: 1.5K/3km. Measurement Accuracy attribute applies to clear and cloudy conditions.
3	Atmospheric Vertical Moisture Profile (Surface to100 mb only)
4	Global Sea Surface Winds (Speed and Direction)
5	Cloud Base Height
6	Cloud Cover/Layers
7	Pressure (Surface/Profile)
8	Sea Surface Temperature (SST)
Lower Priority EDRs (no particular order)	
	Aerosol Optical Thickness
	Albedo
	Cloud Effective Particle Size
	Cloud Liquid Water
	Cloud Optical Thickness
	Cloud Top Height
	Cloud Top Temperature
	Land Surface Temperature
	Ocean Wave Characteristics – Significant Wave Height
	Precipitation Type/Rate
	Precipitable Water
	Snow Cover/Depth
	Soil Moisture (Surface)
	Suspended Matter
	Total Water Content

50.2 NPP Environmental Data Records

The NPP Mission will produce a series of Environmental Data Records (EDRs) which is a subset of the NPOESS EDRs which are detailed in the NPOESS Technical Requirements Document (TRD), Appendix D. For the NPP Mission, the latency requirements listed in the NPOESS TRD Appendix D are not applicable. The NPOESS System must make NPP satellite data (including the EDRs listed below) available per the latency requirement in TRD3.2.1.2.1-13. NPP will produce the following EDRs:

1. Atmospheric Vertical Temperature Profile
2. Atmospheric Vertical Moisture Profile
3. Imagery *
4. Sea Surface Temperature *
5. Soil Moisture *
6. Aerosol Optical Thickness **
7. Aerosol Particle Size **
8. Albedo
9. Cloud Base Height *
10. Cloud Cover/Layers
11. Cloud Effective Particle Size
12. Cloud Optical Thickness
13. Cloud Top Height
14. Cloud Top Pressure
15. Cloud Top Temperature
16. Sea Ice
17. Ice Surface Temperature
18. Land Surface Temperature
19. Net Heat Flux **
20. Vegetation Index
21. Ocean Color
22. Pressure *
23. Snow Cover and Depth *
24. Suspended Matter
25. Surface Type
26. Precipitable Water *

* Requires sensors not flown on NPP to satisfy “cloudy/all weather” attribute thresholds.

** Requires sensors not flown on NPP to satisfy attribute thresholds.

APPENDIX F

ACRONYMS and ABBREVIATIONS

(See the NPOESS Master Acronym List in the NPOESS Contractor's Library)

APPENDIX G

POTENTIAL PRE-PLANNED PRODUCT IMPROVEMENTS

Version 6B

August 23, 2001

70.1 Potential Pre-planned Product Improvements

This paragraph describes elements of the NPOESS mission needs having potentially restrictive technical or programmatic uncertainties identified as a result of Phase 0 Concept studies. DOC and DoD maintain a need for these observations, and prioritize them in terms of mission criticality below. The NPOESS Demonstration/ Validation (Phase 1) allows for continued examination of possible solutions to these needs, including new or modified instrumentation in future space segments beyond NPOESS IOC. Candidate technologies for meeting these needs should be examined in NPOESS Phase 1 for possible inclusion at a later time. No thresholds are stated.

70.1.1 Tropospheric Winds (DOC/DoD)

Wind measured throughout the troposphere. Wind profile required for cloud returns and planetary boundary layer aerosol returns.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage		Surface to 20 km
b. Horizontal Resolution		50 km
c. Vertical Reporting Interval		0.1 km
d. Mapping Uncertainty		10 km
e. Measurement Range		0 to 100 m/s
f. Measurement Precision		0.5 m/s, vector winds
g. Measurement Accuracy		±1 m/s, horiz. components
h. Latency		15 min
i. Refresh		1 hour

70.1.2 CH_4 (Methane) Column (DOC). Measure of amount of methane contained in a specified volume of air.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage		Total column
b. Horizontal Resolution		100 km
c. Mapping Uncertainty		25 km
d. Measurement Range		40 to 80 μmoles/cm^2
e. Measurement Precision		1 %
f. Measurement Accuracy		5 %
g. Latency		15 min
h. Refresh		24 hours

70.1.3.3 CO (Carbon Monoxide) Column (DOC). Measure of carbon monoxide in a specified volume of air.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage		Total column
b. Horizontal Resolution		100 km
c. Mapping Uncertainty		25 km
d. Measurement Range		0 to 7 μmoles/cm^2
e. Measurement Precision		3 %
f. Measurement Accuracy		±5 %
g. Latency		15 min
h. Refresh		24 hours

70.1.4 CO_2 (Carbon Dioxide) Column (DOC). Retrievals of column and total carbon dioxide, calibrated by the users with ground-based measurements, of stated precision needed to afford deduction of long-term variations and trends.

Systems Capabilities	Thresholds	Objectives

a. Vertical Coverage	Total column
b. Horizontal Resolution	100 km
c. Mapping Uncertainty	25 km
d. Measurement Range	11,000 to 15,000 μmoles/cm^2
e. Measurement Precision	15 to 20 μmoles/cm^2
f. Measurement Accuracy	TBD
g. Latency	15 min
h. Refresh	24 hours

NOTE: Carbon dioxide, carbon monoxide, and methane column data are required by NOAA to accomplish its climate mission. In order to predict the concentrations of trace gases in the troposphere, the spatial distributions of the sources and sinks of these gases shall be known. For species with long atmospheric lifetimes, this requires very precise total column data. Values of the absolute accuracies of these gases needed for adequate predictions would not be as strict as the precision requirements due to the availability of supporting ground-based measurements. Long-term trends/variations in the amounts of these gases in the atmosphere are almost certainly addressed best by carefully calibrated ground-based measurements. However, the satellite retrievals would allow for important assessments of the geographical distribution of patterns or gradients in the trace gas concentrations that are not feasible otherwise.

70.1.5 Optical Backgrounds (DoD). Emissions are the result of interactions between precipitating energetic particles and solar ultraviolet radiation with neutral atmospheric constituents.

Systems Capabilities	Thresholds	Objectives
a. Coverage		Global
b. Horizontal Resolution		10 km
c. Mapping Uncertainty		50 km
d. Measurement Range		
1. Wavelength		1 to 29 microns, 0.4 to 0.7 microns, 0.04 to 0.2 microns
2. Brightness		TBD
e. Measurement Precision		TBD
f. Measurement Accuracy		TBD
g. Latency		15 min
h. Refresh		each orbit

70.1.6 All Weather Day/Night Imagery (DoD/DOC). All weather day/night imagery of selected regions. Imagery shall allow discernment of environmental phenomena, including sea ice (by either manual analysis or automated algorithms) and provide digital input to remote sensing algorithms which produce other EDRs.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Spatial Resolution		
1. Regional Scale	100 m (50 m pixels, 8-16 looks)	50 m (25 m pixels, 8-16 looks)
2. Littoral Scale	25 m (12.5 m pixels, 4-8 looks)	12.5 m (6.25 m pixels, 4-8 looks)
3. Local Scale	5 m (2.5 m pixels, 2-3 looks)	1 m (0.5 m pixels, 2-3 looks)
b. Swath Width		
1. Regional Scale	500 km	1000 km
2. Littoral Scale	130 km	200 km
3. Local Scale	30 km	100 km

c. Mapping Uncertainty		
1. Regional Scale	100 m	50 m
2. Littoral Scale	25 m	12.5 m
3. Local Scale	5 m	1 m
d. Refresh		
1. Regional Scale	48 hours	24 hours
2. Littoral Scale	24 hours	12 hours
3. Local Scale	12 hours	1 hours
e. Radiometric Accuracy	1.5 dB	1.0 dB
f. Long-Term Stability	1.0 dB Absolute	0.5 dB Absolute
g. Latency	2 hr	1 hr
h. Geographic Coverage	30 min/orbit on-time. Map ice-covered regions of globe and U.S. Coasts every 3 days. Cover selected areas worldwide. No data below 15 degrees incidence angle.	½ orbit on-time. Map ice-covered regions of globe and U.S. Coasts every 3 days. Cover selected areas worldwide. No data below 15 degrees incidence angle.
i. Orbit Constraints	Global Accessibility. No hole at the pole.	Global Accessibility. No hole at the pole.
j. Retasking	2 hr	1 hr

70.1.7 <u>Sea and Lake Ice Concentration/Age/Motion/Edge Location (DOC)/(DoD).</u> <u>Ice</u> properties derived from imagery. The requirements below apply under both clear and cloudy conditions for sea ice and ice in the Great Lakes. This requirement applies to ice covered oceans and lakes.

<u>Systems Capabilities</u>	<u>Thresholds</u>	<u>Objectives</u>
a. Vertical Coverage	Ice Surface	Ice Surface
b. Horizontal Cell Size		
Ice Concentration/ Age/Motion/Edge Location (all weather)	0.1 km	0.05 km
c. Mapping Uncertainty	0.1 km	0.05 km
d. Measurement Range		
1. Ice Concentration	1/10 to 10/10 (10-100 %)	0/10 to 10/10 (0-100 %)
2. Ice Age	Ice free, young, First year, multiyear	Ice free, Nilas, Grey White, Grey White, First Year Medium, First Year Thick, Second Year, and Multiyear Smooth and Deformed Ice
3. Ice Motion	0-75 km/day	0 to 75 km/day
4. Edge Location	$36^0 – 90^0$N and 50^0 to 80^0 S	$36^0 – 90^0$N and 50^0 to 80^0 S
e. Measurement Uncertainty		
1. Ice Concentration	1%	5% increments
2. Ice Age (probability of correct typing)	85%	95%
3. Ice Motion	0.2 km/day	0.1 km/day
4. Edge Location	0.1 km	0.1 km
f. Refresh	24 hours	6 hours
g. Long-Term Stability		
1. Ice Concentration	1 %/decade	
2. Noise Equivalent sigma 0	-30 dB	-32 dB
i. Range of Incident angles	25 to 55°	25 to 55°

j. Geographic Coverage	All ice-covered regions of the global ocean and Great Lakes	Same as Threshold
k. Orbit Constraints	Coverage of all ice-covered regions of world – no hole at the pole	Same as Threshold

70.1.8 Littoral Currents (DoD). Littoral scale, within 100 km of shore, motion of the water column driven by tidal, wind and density forcing. The types of current that shall be measured are tidal, permanent, wave-induced, wind-induced, longshore and rip currents. Currents are a vector quantity with both speed and direction. This EDR is required under all weather and lighting conditions.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage		0 to 30 m
b. Horizontal Cell Size		0.1 km
c. Vertical Cell Size		Average vector for 1 m layers
d. Mapping Uncertainty		0.1 km
e. Measurement Range		0 to 5 m/s, 0 to 360^{o}
f. Measurement Precision		0.128 m/s, 1^{o}
g. Measurement Accuracy		0.128 m/s, 1^{o}
h. Refresh		3 hours
i. Latency		15 minutes

70.1.9. Coastal Ocean Color (DoD/DOC). Coastal coverage refers to the areal extent consistent with the U.S. Exclusive Economic Zones (EEZ) which extend 370 km from shore. Coastal coverage shall entail roughly 300 km swath coverage, but pertains to all coasts worldwide to support civil and military observations. Ocean color is defined as the spectrum of water-leaving radiances (L_w), i.e., the portion of visible – near infrared light that is reflected out of the water column, excluding light reflected at the surface. All geophysical quantities of interest, e.g., the concentration of the phytoplankton pigment chlorophyll *a* (chlorophyll-*a*) and the inherent optical properties of absorption and scattering of surface waters (ocean optical properties), are derived from these L_w values. Water-leaving radiances are measured in mW cm^{-2} μm^{-1} sr^{-1}. Ocean optical properties, absorption and scattering, are estimated at each measured visible wavelength, and have units of inverse meters (m^{-1}) while Chlorophyll *a* is measured in mg/m. This EDR is required for clear daytime conditions only, for selected lakes, rivers, estuaries, bays, and other coastal regions that require higher resolution data. Note: Operational requirements are DoD/DOC, while Science requirements are DOC only and permit post-processing with additional ancillary data.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
1. Nadir	0.1 km	
2.Worst case	0.2 km	0.1 km
b. Mapping Uncertainty		
1.Nadir	0.1 km	
2.Worst case	0.2 km	0.1 km
c. Measurement Range		
1. Ocean Color	1.0 - 10 W m^{-2} μm^{-1} sr^{-1}	0. 05-10 W m^{-2} μm^{-1} sr^{-1}
2. Optical Properties.		
a. Absorption	0.01 - 10 m^{-l}	005 - 20 m^{-l}
b. Scattering	0.02 - 50 m^{-l}	0.005 - 75 m^{-l}
c. Chlorophyll	Detectable signal in waters witl	Detectable signal in waters

fluorescence	chlorophyll from 0.25 to 50 mg/m^3 at 1 km resolution	with chlorophyll from 0.1 to 50 mg/m^3 at 1 km resolution
3. Chlorophyll	0.01 to 50 mg/m^3	0.001-100 mg/m^3
d. Measurement Precision		
1. Ocean Color		
a.Operational	5 %	2 %
b. Science Quality	2 %	1 %
2. Optical Properties		
a .Operational	30 %	20 %
b. Science Quality	20 %	10 %
3. Chlorophyll		
a .Operational	20 %	10 %
b. Science Quality	10 %	5 %
e. Measurement Accuracy		
1. Ocean Color		
a. Operational	10 %	5 %
b. Science Quality	5 %	3 %
2. Optical Properties		
a .Operational	40 %	30 %
b. Science Quality	30 %	20 %
3. Chlorophyll		
a .Operational	40 %	20 %
b. Science Quality	30 %	10 %
f. Refresh	24 hours	4 hours
g. Long-Term Stability	$W\ m^{-2}\ \mu m^{-1}\ sr^{-1}$ Max Chlorophyll Absorption: 0.50 Min Chlorophyll Absorption: 0.25 Atmospheric Correction: 0.08	$W\ m^{-2}\ \mu m^{-1}\ sr^{-1}$ Max Chlorophyll Absorption: 0.250 Min Chlorophyll Absorption: 0.125 Atmospheric Correction: 0.040
h. Latency		
1. Operational	3 hours	1 hour
2. Science Quality	48 hours	24 hours
i. Geographic Coverage	Selected coastal regions, rivers and lakes, U.S. and worldwide	Selected coastal regions, rivers and lakes, U.S. and worldwide

70.1.10. Bioluminescence Potential (DoD). An estimate of the potential number of flashes generated by bioluminescent organisms present in sea water within a region.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
Nadir	1.0 km	
Worst case	2.4 km	0.65 km
b. Mapping Uncertainty		
Nadir	1.0 km	
Worst case	3 km	0.5 km
c. Measurement Accuracy		TBD
d. Refresh	24	12
e. Long-Term Stability	TBD	TBD
f. Latency	3 hours	1 hour
g. Geographic Coverage	Global	Global

70.1.11 Coastal Sea Surface Temperature (SST) (DOC/DoD). Coastal coverage refers to the areal extent consistent with the U.S. Exclusive Economic Zones (EEZs) which extend 370 km from shore. Coastal coverage shall entail roughly 300 km swath coverage, but pertains to all coasts worldwide to support civil and military observations. Sea surface temperature is defined as the temperature of the surface layer (upper 1 meter) of ocean water. It has two major applications: 1) sea surface phenomenology, and 2) use in infrared cloud/no cloud decision for processed cloud data. The requirements below apply only under clear conditions for selected lakes, rivers and coastal regions that require high resolution data.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
Nadir	0.1 km	
Worst case	0.2 km	0.1 km
b. Mapping Accuracy		
Nadir	0.1 km	
Worst case	0.2 km	0.1 km
c. Measurement Range	-2^{o} to 40^{o} C	-2° to 40° C
d. Measurement Precision	0.4^{o} C	0.1° C
e. Measurement Uncertainty	0.7° C	0.2° C
f. Refresh	12 hours	6 hours
g. Long-Term Stability	TBD	
h. Latency	2 hr	1 hr
i. Geographic Coverage	U.S. coastal areas and selected coastal areas and lakes worldwide	Same as Threshold

70.1.12 Coastal Sea Surface Winds (Speed and Direction) and Wind Stress (DOC). Coastal coverage refers to the areal extent consistent with the U.S. Exclusive Economic Zones (EEZ) which extend 370 km from shore. Coastal coverage shall entail roughly 300 km swath coverage, but pertains to all coasts worldwide to support civil and military. This EDR also pertains to selected open ocean areas. Measure of atmospheric wind speed/direction at the sea/atmosphere interface (10 meter height neutral stability winds) in clear sky and cloudy conditions, for integrated rainfall rates less than 2 mm/hr/km^2. Wind stress measurements observe the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
Minimum distance to shore	1 km	300 m
b. Mapping Uncertainty	1 km	300 m
c. Measurement Range		
1 Wind Speed/Direction	3 to 35 m/s, 0 to 360^{o}	2 to 50 m/s, 0 to 360^{o}
2. Wind Stress	0 to 3 N/m^2, 0-360^{o}	0 to 10 N/m^2, 0-360^{o}
d. Measurement Uncertainty (Wind Speed and Direction)		
1. Speed[1]	greater of 2 m/s or 10 %	greater of 1 m/s or 10 %
2. Direction[2]	TBD	10^{o}
e. Measurement Precision (Wind Stress)		
1. Stress	0.02 N/m^2	0.01 N/m^2
2. Stress Direction	TBD	TBD
f. Measurement Accuracy		

(Wind Stress)		
Speed	0.02 N/m^2	0.01N/m^2
Direction	TBD	TBD
g. Refresh	6 hours	2 hours
h. Latency	2 hours	1 hour
i. Geographic Coverage	U.S. EEZ up to coast and in lakes, bays and estuaries; selected open ocean regions worldwide not to exceed 30 minutes each orbit	U.S. EEZ up to coast and in lakes, bays and estuaries; selected open ocean regions worldwide not to exceed 30 minutes each orbit

[1]NOTE: Not more than 25% of the wind speed uncertainty should be attributed to a wind speed bias (i.e., no more than 6.25% of the square of the RMS error should be due to the bias).

[2]NOTE: Direction uncertainty is to be applied to the unique chosen ambiguity.

70.1.13 Sea Surface Height Coastal (DoD). Coastal Sea Surface Height differs from Sea Surface Height by a shorter Distance to Shore measure. Sea surface height is the topography of the ocean surface with respect to the Earth's reference ellipsoid. Coastal sea level variability is required for estimation of tidal sea level variations and tidal current variations. The requirements below apply under both clear and cloudy conditions. Note: following terminology is altimeter-specific and is found in "DEFINITIONS PERTAINING TO SEA SURFACE HEIGHT" in Attachment 3.

Systems Capabilities	Threshold	Objective
a. Horizontal Resolution		
1. Along-track		0.3 km
2. Cross-track		5 km
3. Distance to shore		0 km
b. Radial Orbit Determination		
Accuracy		10 cm
Timeliness		1 hour
c. Measurement Precision		2 cm
d. Measurement Accuracy		2 cm
e. Refresh		3 hours
f. Tidal Aliasing		2 cm
g. Geographic Coverage	66S to 66N latitude	85S to 85N latitude

70.1.14 Coastal Imagery (DoD/DOC). Coastal coverage refers to the areal extent consistent with the U.S. Exclusive Economic Zone (EEZ) which extends 370 km from shore. Coastal coverage shall entail roughly 300 km swath coverage, but pertains to all coasts worldwide to support civil and military observations. Specialized imagery at sufficient resolution to enable discernment of environmental phenomena (by either manual analysis or automated algorithms) for oceanographic observations. Imagery shall provide digital input, through single bands and/or combinations of band/channels, to remote sensing algorithms which produce other environmental measurements, although this does not replace the explicit requirement for retrieval of individual parameters described elsewhere in this document.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
1. Nadir	0.1 km	
2.Worst case	0.2 km	0.1 km
b. Mapping Uncertainty		
1.Nadir	0.1 km	

2.Worst case	0.2 km	0.1 km
c. Refresh	12 hours	6 hours
d. Long-Term Stability	N/A	
e. Latency	2 hrs	1 hr
f. Geographic Coverage	U.S. coastal areas and selected coastal areas and lakes worldwide	Same as Threshold

70.1.15 Ocean Wave Characteristics - Ocean Wave Direction / Wavelength (DoD/DOC). The direction and wavelength of ocean waves. The requirements below apply under both clear and cloudy conditions. Note 1: Refresh requirement is to provide observations along the satellite nadir-track of any satellite carrying an altimeter if an altimeter is used, or within the footprint of an Active Microwave scene, if applicable.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size	2.5 – 20 km (Sea state dependent)	2.5km
b. Mapping Uncertainty	10 km	5 km
c. Measurement Range		
1. Wavelength	100 - 700 m	50 - 700 m
2. Direction	0 to 360^o	0 to 360^o
d. Measurement Precision		
1. Wavelength	10 m	5 m
2. Direction	10^o	5^o
e. Measurement Accuracy		
1. Wavelength	10 m or 10 %, whichever is greater	5 m or 5 %, whichever is greater
2. Direction	10^o	5^o
f. Refresh	See Note 1	See Note 1
g. Latency	2 hours	1 hour
h. Geographic Coverage	Global Ice-free Oceans	Global Ice-free Oceans

70.1.16 Surf Conditions (DoD). This is a Navy requirement to support amphibious and special operations. This is also useful for monitoring/predicting coastal erosion. Characterize surf height, type and period/wavelength in all weather conditions.

a. Location of Surf Zone (DoD). This defines the location of the breaking waves and how far from shore the waves start to break. The location of the surf zone should not change very rapidly, although it will depend on the sea state (thus an increasing sea state may increase wave height, thus increase the distance from shore of breaking waves) which can change on the scale of a few hours. However, if one knows the surf zone location for the last 12 hours, it may still be a useable estimate.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Spatial Resolution		
1. Cross-shore cell size	0.025 km	0.01 km
2. Along-shore cell size	0.1 km	0.1 km
b. Mapping Uncertainty	0.01 km	0.001 km
c. Measurement Range	0-100 m	0-100 m
d. Measurement Precision	10 m	1 m
e. Measurement Accuracy	10 m	1 m
f. Refresh	12 hours	1 hour

b. Breaking Wave Height. This defines the height of the breaking wave within the surf zone. This will determine whether a landing is even possible and is an essential piece of information for the surf zone index.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Spatial Resolution		
1. Cross-shore cell size	0.025 km	0.01 km
2. Along-shore cell size	0.1 km	0.01 km
b. Mapping Uncertainty	0.01 km	0.001 km
c. Measurement Range	0-5 m	0-5 m
d. Measurement Precision	0.5 m	0.5 m
e. Measurement Accuracy	0.5 m	0.5 m
f. Refresh	12 hours	1 hour

c. Surf Zone Currents. This defines the currents in the proximity of the surf zone and is necessary for amphibious operations during STOM (Ship To Objective Maneuver) operations.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Spatial Resolution		
1. Cross-shore cell size	0.025 km	0.05 km
2. Along-shore cell size	0.1 km	0.05 km
b. Mapping Uncertainty	0.25 km	0.001 km
c. Measurement Range	0-3 m/s	0-3 m/s
d. Measurement Precision	0.25 m/s	0.1 m/s
e. Measurement Accuracy	0.25 m/s	0.1 m/s
f. Refresh	12 hours	1 hour

d. Surf Zone Bathymetry. This defines the depth of water in the proximity of the surf zone and allows commanders to determine which systems (surface and sub-surface) will be capable of operations in that area.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Spatial Resolution		
1. Cross-shore cell size	0.025 km	0.001 km
2. Along-shore cell size	0.1 km	0.005 km
b. Mapping Uncertainty	0.025 km	0.001 km
c. Measurement Range	0-5 m	0-5 m
d. Measurement Precision	0.5 m	0.1 m
e. Measurement Accuracy	0.5 m	0.1 m
f. Refresh	1 week	1 week

70.1.17 Bathymetry (Deep Ocean and Near Shore) (DoD). Vertical depth of water. Note: Requires SAR/hyperspectral for coastal areas and next generation altimeter for deep ocean.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage		
1. Deep Ocean		0 to 300 m
2. Near shore		0 to 200 m, See Note 1
b. Horizontal Resolution		
1. Deep Ocean		300 m
2. Near shore		30 m
c. Vertical Cell Size		
Deep Ocean		1 m
Near Shore		0.5 m
d. Mapping Uncertainty		10 m
e. Measurement Accuracy		0.3 m

f. Refresh	48 hours
g. Latency	4 hours

Note 1: "near shore" means "outside of the surf zone."

70.1.18 Salinity (DoD/DOC). This parameter is the quantity of dissolved materials in sea water. A formal definition is "the total amount of solid materials, in grams, contained in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all organic matter is completely oxidized." Traditional units of measurement are parts per thousand (ppt), by weight; however, today, a "practical salinity scale" based on the ratio of the electrical conductivity of a seawater sample to that of standard seawater at 35 ppt is commonly used.

Systems Capabilities	Thresholds	Objectives
a. Vertical Coverage	Surface	0 to 300 m
b. Horizontal Resolution	75 km	0.25 km
c. Vertical Cell Size	N/A	2 m
d. Mapping Uncertainty	20 km	0.25 km
e. Measurement Range	32 to 38 ppt	0 to 40 ppt
f. Measurement Precision	.1 ppt	0.5 ppt
g. Measurement Accuracy	.1 ppt	0.5 ppt
h. Refresh	7 days	3 hours
i. Latency	90 minutes	15 minutes

70.1.19 Oil Spill Location (DOC). All-weather, day/night, high-resolution maps of oil spills on the ocean, on lakes, and on larger rivers. Only regional coverage is required for selected monitoring areas. Tasking must be rapid (24 hours or less) to respond to spills as they occur in U.S. waters and other regions of interest worldwide. The threshold output product is an oil/no oil determination on a map. The objective output product further distinguishes between biogenic and mineral oil.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
1.Regional Scale	50 m (8-16 looks)	25 m
2. Littoral Scale	12.5 m (4-8 looks)	6.25 m
3. Local Scale	5 m (2-3 looks)	0.5 m
b. Mapping Uncertainty		
1. Regional Scale	100 m	50 m
2. Littoral Scale	25 m	12.5 m
3. Local Scale	5 m	1 m
c. Measurement Range (within a wind speed range of 3-12 m/s)	Oil/no oil differentiation	Oil/no oil and natural seep or spill / biogenic slick differentiation
d. Measurement Precision		
1. Regional Scale	50 m	25 m
2. Littoral Scale	12.5 m	6.2 m
3. Local Scale	2.5 m	0.5 m
e. Measurement Accuracy	70 % correctly detected	90 % correctly detected and classified
f. Refresh	2 days	3 hours
g. Long-Term Stability	±0.5 dB instrument to instrument	±0.2 dB instrument to instrument

70.1.20 Vertical Hydrometeor Profile (DOC). Vertical profile of precipitating water and precipitating ice (mean in volume).

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	25 km	5 km
b. Vertical Resolution	3 km	2 km
c. Mapping Accuracy	5 km	1 km
d. Range	0-3.0 g/m^3	0-3.0 g/m^3
e. Precision	greater of 0.2 g/m^3 or 10%	greater of 0.1 g/m^3 or 4 %
f. Accuracy	greater of 0.4 g/m^3 or 25%	greater of 0.2 g/m^3 or 10 %
g. Refresh	6 hours	4 hours
h. Long-term Stability	greater of 0.1 g/m^3 or 5 %	greater of 0.05 g/m^3 or 1 %

70.1.21 Neutral Winds (DoD/DoC). Measurement of the horizontal neutral wind in the upper thermosphere.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size	250 km	250 km
b. Vertical Cell Size	15 km	15 km
c. Horizontal Coverage	Global	Global
d. Vertical Coverage	90 to 500 km	90 to 500 km
e. Measurement Range	0 to ±1500 m s^{-1}	0 to ±1500 m s^{-1}
f. Measurement Uncertainty	Greater of 5 m s^{-1} or 5 %	Greater of 5 m s^{-1} or 5 %
g. Latency	90 minutes	15 minutes